NOAA Technical Memorandum NWS WR-115

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

Brian W. Finke

Weather Service Forecast Office
Los Angeles, California

February 1977

UNITED STATES
DEPARTMENT OF COMMERCE
Juanita M. Kreps, Secretary

NATIONAL OCEANIC AND
ATMOSPHERIC ADMINISTRATION
Robert M. White, Administrator

NATIONAL WEATHER
SERVICE
George P. Cressman, Director

CONTENTS

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

Brian W. Finke
Weather Service Forecast Office
National Weather Service Western Region
NOAA, Los Angeles, California

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.

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.						
	$K = (60\,min/hr)(1\,nmi/6060\,ft)(10^{-2})$						
3		K	STO	0			K
4		H1	STO	1			
		α_1	STO	2			
		θ_1	STO	3			
		H2	STO	4			
		α_2	STO	5			
		θ_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	CODE	KEY ENTRY	X	Y	Z	T	COMMENTS
00			–	–	–	–	Enter height and
01		RCL1	H1	–	–	–	elevation angle.
02		RCL2	α1	H1	–	–	
03		f TAN	tan α1	H1	–	–	Calculate horizon-
04		g 1/x	ctn α1	H1	–	–	tal distance out.
05		X	H1 ctnα1	–	–	–	
06		9	9	H1 ctn α1	–	–	
07		0	90	H1 ctn α1	–	–	Azimuth angle
08		RCL3	θ1	90	H1 ctn α1	–	adjustment.
09		–	90–θ1	H1 ctn α1	–	–	
10		X ≶ y	H1 ctn α1	90–θ1	–	–	
11		f → R	x1	y1	–	–	Calculate x1 and
12		RCL4	CR4	x1	y1	–	y1. Retrieve R4
13		g x=o	CR4	x1	y1	–	test R4. If R4=0,
14		GTO 27	CR4	x1	y1	–	If R4≠0, X1 stored
15		R↓	x1	y1	–	CR4	in R1, Y1 stored
16		STO 1	x1	y1	–	CR4	in R2, retrieve θ2
17		X ≶ y	y1	x1	–	CR4	and store in R3.
18		STO 2	y1	x1	–	CR4	
19		RCL6	θ2	y1	x1	–	
20		STO 3	θ2	y1	x1	–	
21		RCL 4	H2	θ2	y1	x1	Retrieve H2
22		RCL 5	α2	H2	θ2	y1	Retrieve α2
23		0	0	α2	H2	θ2	
24		STO 4	0	α2	H2	θ2	Store 0 in R4
25		R↓	α2	H2	θ2	0	Position H2 and α2
26		GTO 03	α2	H2	θ2	0	
27		R↓	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≶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≶y	x2–x1	y2–y1	0	0	Obtain windspeed
34		g→ 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≶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	
R0	K
R1	H1, x1
R2	α1, y1
R3	θ1, θ2
R4	H2, 0
R5	α2
R6	θ2
R7	

HEWLETT hp PACKARD

No. 45/2 Precipitation Probabilities in the Western Region Associated with Spring 500-mb Map Types. Richard P. Augulis. January 1970. (Out of print.) (PB-189434)

No. 45/3 Precipitation Probabilities in the Western Region Associated with Summer 500-mb Map Types. Richard P. Augulis, January 1970. (Out of print.) (PB-189414)

No. 45/4 Precipitation Probabilities in the Western Region Associated with Fall 500-mb Map Types. Richard P. Augulis, January 1970. (Out of print.) (PB-189435)

No. 46 Applications of the Net Radiometer to Short-Range Fog and Stratus Forecasting at Eugene, Oregon. L. Yee and E. Bates, December 1969. (PB-190476)

No. 47 Statistical Analysis as a Flood Routing Tool. Robert J. C. Burnash, December 1969. (PB-188744)

No. 48 Tsunami. Richard P. Augulis, February 1970. (PB-190157)

No. 49 Predicting Precipitation Type. Robert J. C. Burnash and Floyd E. Hug, March 1970. (PB-190962)

No. 50 Statistical Report on Aeroallergens (Pollens and Molds) Fort Huachuca, Arizona, 1969. Wayne S. Johnson, April 1970. (PB-191743)

No. 51 Western Region Sea State and Surf Forecaster's Manual. Gordon C. Shields and Gerald B. Burdwell, July 1970. (PB-193102)

No. 52 Sacramento Weather Radar Climatology. R. G. Pappas and C. M. Veliquette, July 1970. (PB-193347)

No. 53 Experimental Air Quality Forecasts in the Sacramento Valley. Norman S. Benes, August 1970. (Out of print.) (PB-194128)

No. 54 A Refinement of the Vorticity Field to Delineate Areas of Significant Precipitation. Barry B. Aronovitch, August 1970.

No. 55 Application of the SSARR Model to a Basin Without Discharge Record. Vail Schermerhorn and Donald W. Kuehl, August 1970. (PB-194394)

No. 56 Areal Coverage of Precipitation in Northwestern Utah. Philip Williams, Jr., and Werner J. Heck, September 1970. (PB-194389)

No. 57 Preliminary Report on Agricultural Field Burning vs. Atmospheric Visibility in the Willamette Valley of Oregon. Earl M. Bates and David O. Chilcote, September 1970. (PB-194710)

No. 58 Air Pollution by Jet Aircraft at Seattle-Tacoma Airport. Wallace R. Donaldson, October 1970. (COM-71-00017)

No. 59 Application of P.E. Model Forecast Parameters to Local-Area Forecasting. Leonard W. Snellman, October 1970. (COM-71-00016)

NOAA Technical Memoranda NWS

No. 60 An Aid for Forecasting the Minimum Temperature at Medford, Oregon. Arthur W. Fritz, October 1970. (COM-71-00120)

No. 61 Relationship of Wind Velocity and Stability to SO_2 Concentrations at Salt Lake City, Utah. Werner J. Heck, January 1971. (COM-71-00232)

No. 62 Forecasting the Catalina Eddy. Arthur L. Eichelberger, February 1971. (COM-71-00223)

No. 63 700-mb Warm Air Advection as a Forecasting Tool for Montana and Northern Idaho. Norris E. Woerner, February 1971. (COM-71-00349)

No. 64 Wind and Weather Regimes at Great Falls, Montana. Warren B. Price, March 1971.

No. 65 Climate of Sacramento, California. Wilbur E. Figgins, June 1971. (COM-71-00764)

No. 66 A Preliminary Report on Correlation of ARTCC Radar Echoes and Precipitation. Wilbur K. Hall, June 1971. (COM-71-00829)

No. 67 Precipitation Detection Probabilities by Los Angeles ARTC Radars. Dennis E. Ronne, July 1971. (Out of print.) (COM-71-00925)

No. 68 A Survey of Marine Weather Requirements. Herbert P. Benner, July 1971. (Out of print.) (COM-71-00889)

No. 69 National Weather Service Support to Soaring Activities. Ellis Burton, August 1971. (Out of print.) (COM-71-00956)

No. 70 Predicting Inversion Depths and Temperature Influences in the Helena Valley. David E. Olsen, October 1971. (Out of print.) (COM-71-01037)

No. 71 Western Region Synoptic Analysis-Problems and Methods. Philip Williams, Jr., February 1972. (COM-72-10433)

No. 72 A Paradox Principle in the Prediction of Precipitation Type. Thomas J. Weitz, February 1972. (Out of print.) (COM-72-10432)

No. 73 A Synoptic Climatology for Snowstorms in Northwestern Nevada. Bert L. Nelson, Paul M. Fransioli, and Clarence M. Sakamoto, February 1972. (Out of print.) (COM-72-10338)

No. 74 Thunderstorms and Hail Days Probabilities in Nevada. Clarence M. Sakamoto, April 1972. (COM-72-10554)

No. 75 A Study of the Low Level Jet Stream of the San Joaquin Valley. Ronald A. Willis and Philip Williams, Jr., May 1972. (COM-72-10707)

No. 76 Monthly Climatological Charts of the Behavior of Fog and Low Stratus at Los Angeles International Airport. Donald M. Gales, July 1972. (COM-72-11140)

No. 77 A Study of Radar Echo Distribution in Arizona During July and August. John E. Hales, Jr., July 1972. (COM-72-11136)

No. 78 Forecasting Precipitation at Bakersfield, California, Using Pressure Gradient Vectors. Earl T. Riddiough, July 1972. (COM-72-11146)

No. 79 Climate of Stockton, California. Robert C. Nelson, July 1972. (COM-72-10920)

No. 80 Estimation of Number of Days Above or Below Selected Temperatures. Clarence M. Sakamoto, October 1972. (COM-72-10021)

No. 81 An Aid for Forecasting Summer Maximum Temperatures at Seattle, Washington. Edgar G. Johnson, November 1972. (COM-73-10150)

No. 82 Flash Flood Forecasting and Warning Program in the Western Region. Philip Williams, Jr., Chester L. Glenn, and Roland L. Raetz, December 1972. (COM-73-10251)

No. 83 A Comparison of Manual and Semiautomatic Methods of Digitizing Analog Wind Records. Glenn E. Rasch, March 1973. (COM-73-10669)

No. 84 Southwestern United States Summer Monsoon Source--Gulf of Mexico or Pacific Ocean? John E. Hales, Jr., March 1973. (COM-73-10769)

No. 85 Range of Radar Detection Associated with Precipitation Echoes of Given Heights by the WSR-57 at Missoula, Montana. Raymond Granger, April 1973. (COM-73-11030)

No. 86 Conditional Probabilities for Sequences of Wet Days at Phoenix, Arizona. Paul C. Kangieser, June 1973. (COM-73-11264)

No. 87 A Refinement of the Use of K-Values in Forecasting Thunderstorms in Washington and Oregon. Robert Y. G. Lee, June 1973. (COM-73-11276)

No. 88 A Surge of Maritime Tropical Air--Gulf of California to the Southwestern United States. Ira S. Brenner, July 1973.

No. 89 Objective Forecast of Precipitation Over the Western Region of the United States. Julia N. Paegle and Larry P. Kierulff, September 1973. (COM-73-11946/3AS)

No. 90 A Thunderstorm "Warm Wake" at Midland, Texas. Richard A. Wood, September 1973. (COM-73-11845/AS)

No. 91 Arizona "Eddy" Tornadoes. Robert S. Ingram, October 1973. (COM-74-10465)

NOAA Technical Memoranda NWSWR: (Continued)

No. 92 Smoke Management in the Willamette Valley. Earl M. Bates, May 1974. (COM-74-11277/AS)

No. 93 An Operational Evaluation of 500-mb Type Stratified Regression Equations. Alexander E. MacDonald, June 1974. (COM-74-11407/AS)

No. 94 Conditional Probability of Visibility Less than One-half Mile in Radiation Fog at Fresno, California. John D. Thomas, August 1974. (COM-74-11555/AS)

No. 95 Climate of Flagstaff, Arizona. Paul W. Sorenson, August 1974. (COM-74-11678/AS)

No. 96 Map Type Precipitation Probabilities for the Western Region. Glenn E. Rasch and Alexander E. MacDonald, February 1975. (COM-75-10428/AS)

No. 97 Eastern Pacific Cut-off Low of April 21-28, 1974. William J. Alder and George R. Miller, January 1976. (PB-250-711/AS)

No. 98 Study on a Significant Precipitation Episode in the Western United States. Ira S. Brenner, April 1975. (COM-75-10719/AS)

No. 99 A Study of Flash Flood Susceptibility--A Basin in Southern Arizona. Gerald Williams, August 1975. (COM-75-11360/AS)

No. 100 A Study of Flash-flood Occurrences at a Site versus Over a Forecast Zone. Gerald Williams, August 1975. (COM-75-11404/AS)

No. 101 Digitized Eastern Pacific Tropical Cyclone Tracks. Robert A. Baum and Glenn E. Rasch, September 1975. (COM-75-11479/AS)

No. 102 A Set of Rules for Forecasting Temperatures in Napa and Sonoma Counties. Wesley L. Tuft, October 1975. (PB-246-902/AS)

No. 103 Application of the National Weather Service Flash-flood Program in the Western Region. Gerald Williams, January 1976. (PB-253-053/AS)

No. 104 Objective Aids for Forecasting Minimum Temperatures at Reno, Nevada, During the Summer Months. Christopher D. Hill, January 1976. (PB252866/AS)

No. 105 Forecasting the Mono Wind. Charles P. Ruscha, Jr., February 1976.(PB254650)

No. 106 Use of MOS Forecast Parameters in Temperature Forecasting. John C. Plankinton, Jr., March 1976. (PB254649)

No. 107 Map Types as Aid in Using MOS PoPs in Western U. S. Ira S. Brenner, August 1976. (PB259594)

No. 108 Other Kinds of Wind Shear. Christopher D. Hill, August 1976.(PB260437/AS)

No. 109 Forecasting North Winds in the Upper Sacramento Valley and Adjoining Forests. Christopher E. Fontana, September 1976.

No. 110 Cool Inflow as a Weakening Influence on Eastern Pacific Tropical Cyclones. William J. Denney, November 1976.

No. 111 Operational Forecasting Using Automated Guidance. Leonard W. Snellman, February 1977.

No. 112 The MAN/MOS Program. Alexander E. MacDonald, February 1977.

No. 113 Winter Season Minimum Temperature Formula for Bakersfield, California, Using Multiple Regression. Michael J. Oard, February 1977.

No. 114 Tropical Cyclone Kathleen. James R. Fors, February 1977.