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A COMPARISON BETWEEN GROUND BASED AND AIRCRAFT TRIANGULATION OF CHEMICAL RELEASES IN THE LOWER THERMOSPHERE

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Introduction.

In addition to involving a number of international scientists in a wide variety of upper atmosphere experiments, the AFGL ALADDIN II PROGRAM of June 1974 provided an opportunity (admittedly under less than ideal conditions) to directly compare upper atmosphere winds deduced from photographs of high altitude chemical releases as observed from conventional ground based cameras, and a high flying aircraft.

Observational procedures, recording techniques and data analysis for both types of measurement have appeared in detail elsewhere (ground based: D. L. Albritton et al, Photogrammetric Engineering, September 1962, C. G. Justus, M.S. Thesis, Georgia Tech, June 1963; aircraft: Final Reports on NASA Contracts NAS2-7998, NASW-2308, NASW-2450, by J. F. Bedinger et al, GCA Corporation, Bedford, MA) and the ALLADIN II results for selected releases have been published as technical reports AFGL-TR-76-102 (aircraft) by J. F. Bedinger, and AFGL-TR-76-0063 (ground based) by the present authors. The purpose of this report is to compare the simultaneously measured ground-based and aircraft data from 3 releases, code named PRE-ALADDIN (2110 EDT, 6/28/74), ETTY (2106 EDT, 6/29/74), and JOAN (0330 EDT, 6/30/74).

The data reduction associated with the aircraft observations is much more complex than that of the ground based photographs. With the ground based sites surveyed and the camera orientations suitably calibrated from frames of the star background, the only degrees of freedom of the system are those of the chemical release itself. In the case of the aircraft, an additional six degrees of freedom (aircraft altitude, latitude, longitude, yaw, pitch and roll) are introduced. Some problems were encountered while carrying out the currently reported aircraft mission - on future missions these problems will be considerably reduced, if not eliminated. Ground based observing conditions for the second two releases reported here were far from ideal (ground fog and

scatter cloud).

Explanation of the Tables.

The wind tables give the zonal (EW) and meridional (NS) wind components as measured simultaneously by each of the techniques. Because of observational difficulties, only identifiable trail features were triangulated from the ground based cameras for ETTY and JOAN to produce a few measurements at selected altitudes. Positive wind components indicate winds blowing toward the east and north. Speeds are in meters/sec.

The ground based measurements are characterized by an absolute height error of 1 km, and a wind speed error of from 5 to 10 m/sec, and have been used as the reference set in these comparisons.

Discussion of Results.

The comparisons between the results appearing in the tables are more easily visualized if plotted graphically. Figures 1 and 2 show the zonal and meridional wind components respectively, as determined for the PRE-ALADDIN release. The discrepancy between the ground based and aircraft results can be minimized significantly by a height compression of the aircraft measured trail such that its length corresponds to that of the groundbased trail.

The zonal component of ETTY (Figure 3) shows general agreement between the two data sets, with again a compression of the aircraft trail length leading to a reduction in the discrepancies. However, the meridional are significantly different, with the exception of the point at 136 km. A height compression could be scaled so as not to make much difference to this point, but would not help to reduce the overall discrepancy.

The comparisons for JOAN are complicated by the presence of a very high shear region - here, small height errors make large differences in the relative wind magnitudes. The magnitudes of both the east/west and the north/south

Table 1
 CODE NAME. PREALADDIN 2110 EDT, 6/28/74

Ht, km	AIRCRAFT		GROUND	BASED
	EW, m/s	NS, m/s	EW, m/s	NS, m/s
110	-47	-5	-34	6
112	-43	0	-33	4
114	-41	2	-28	5
116	-38	4	-26	5
118	-34	6	-25	5
120	-29	8	-26	4
122	-24	10	-26	5
124	-18	11	-29	2
126	-14	11.5	-29	-1
128	-14	9	-29	-3
130	-14.5	6	-33	-8
132	-17	2	-35	-10
134	-25	-3	-33	-12
136	-30	-6	-35	-14
138	-35	-8	-37	-17
140	-40	-10	-41	-19
144	-47	-14	-59	-22
148	-54	-18	-61	-26
152	-62	-22	-59	-23
156	-68	-24	-60	-24

Table 2

CODE NAME. ETTY 2106 EDT, 6/29/74

Ht, km	AIRCRAFT		GROUND	BASED
	EW, m/s	NS, m/s	EW, m/s	NS, m/s
90	74	40		
92	76	35		
94	80	29		
96	84	15		
98	90	4		
100	94	-4		
102	99	-6		
104	102	-5		
106	102	10		
107	98	20		
108	80	29		
109	40	3		
110	0	39		
111	-50	38		
112	-90	34		
113	-95	30		
114	-96	27		
115	-94	23		
116	-90	19		
118	-75	11		
120	-64	5		
122	-57	-1		
124	-50	-6		
126	-44	-10		
128	-39	-17		
130	-35	-19		

Table 2 (cont'd)

Ht, km	AIRCRAFT		GROUND	BASED
	EW, m/s	NS, m/s	EW, m/s	NS, m/s
130	-35	-19		
132	-32	-22		
134	-30	-24		
136	-29	-26	-18	-19
138	-29	-28		
140	-30	-30		
142	-32	-32		
144	-35	-34		
146	-39	-36	-41	-65
148	-43	-37		
150	-47	-38		
152	-51	-39		
154	-55	-40		
156	-59	-41	-79	-81
158	-62	-40		
160	-64	-40		
162	-66	-39		
164	-67	-38		
166	-66	-35		
168	-66	-35	-75	-75
170	-64	-34		
172	-62	-33		
174	-58	-31		
176	-55	-29		
178	-52	-27		
180	-50	-25		
182	-46	-23		

Table 3

CODE NAME JOAN 0330 EDT, 6/30/74

Ht, km	AIRCRAFT		GROUND	BALD
	EW, m/s	NS, m/s	EW, m/s	NS, m/s
85	-4	8		
86	4	3		
87	11	-4		
88	20	-20		
89	30	-28		
90	33	-32		
91	32	-30		
92	20	20		
92.5	0	54		
93	-30	56		
94	-39	54		
95	-40	50		
96	-43	40		
97	-44	31		
98	-45	26		
99	-46	23	-1	76
100	-44	20		
101	-38	13		
102	-25	5		
102.5	-10	-0	-32	36
103	9	-2		
103.5	40	-4	-21	18
104	48	-7		
105	55	-10		
106	60	-14		
107	66	-16		
108	68	-19	73	-20
109	66	-22		
110	60	-24		
111	50	-26	24	-57

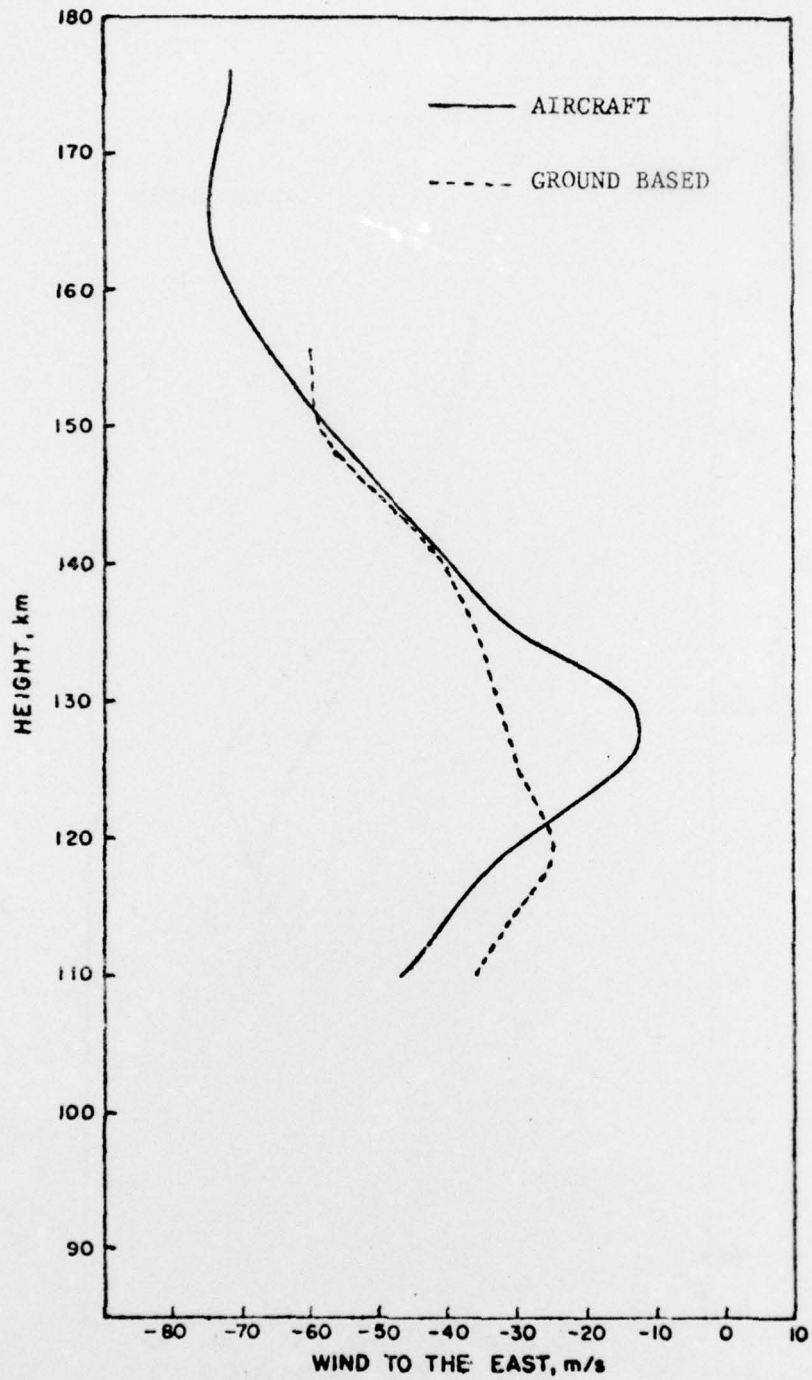


Figure 1 Height Profile of Eastward Winds From PRE-ALADDIN

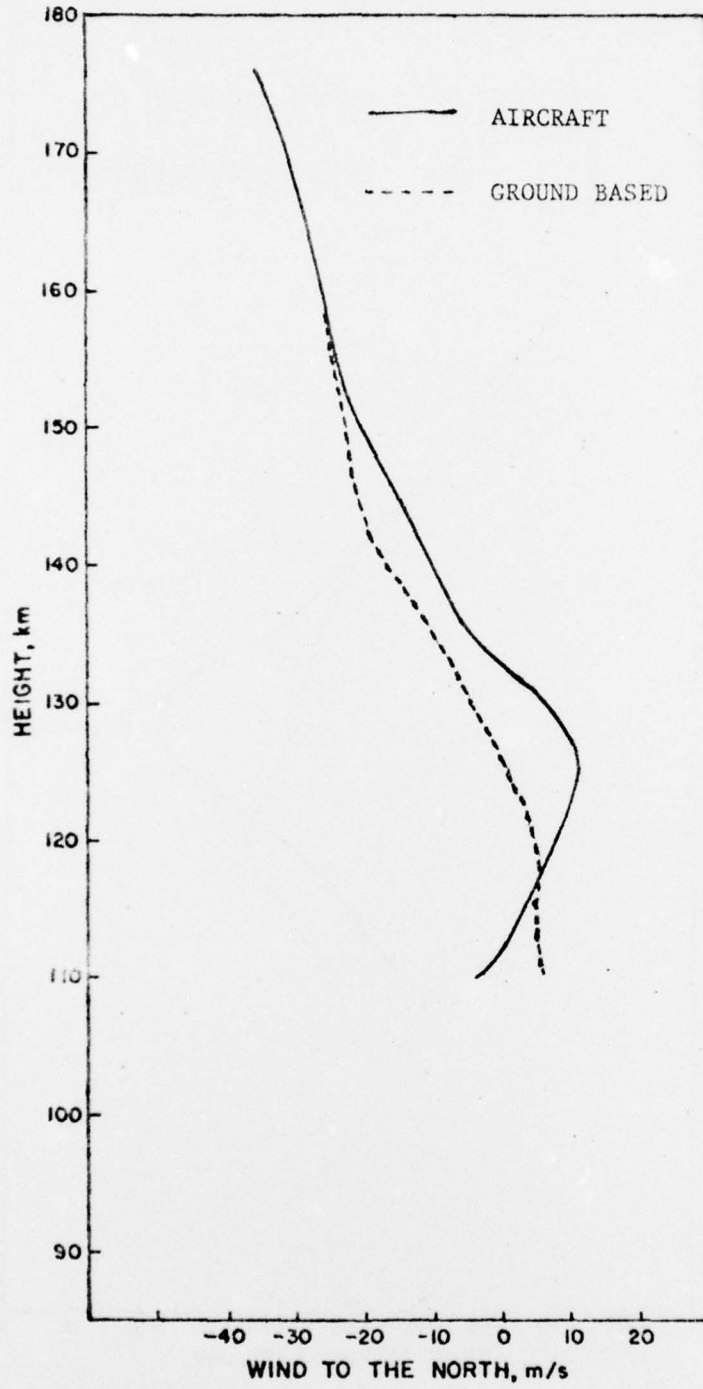


Figure 2. Height Profile of Northward Winds From PRE-ALADDIN

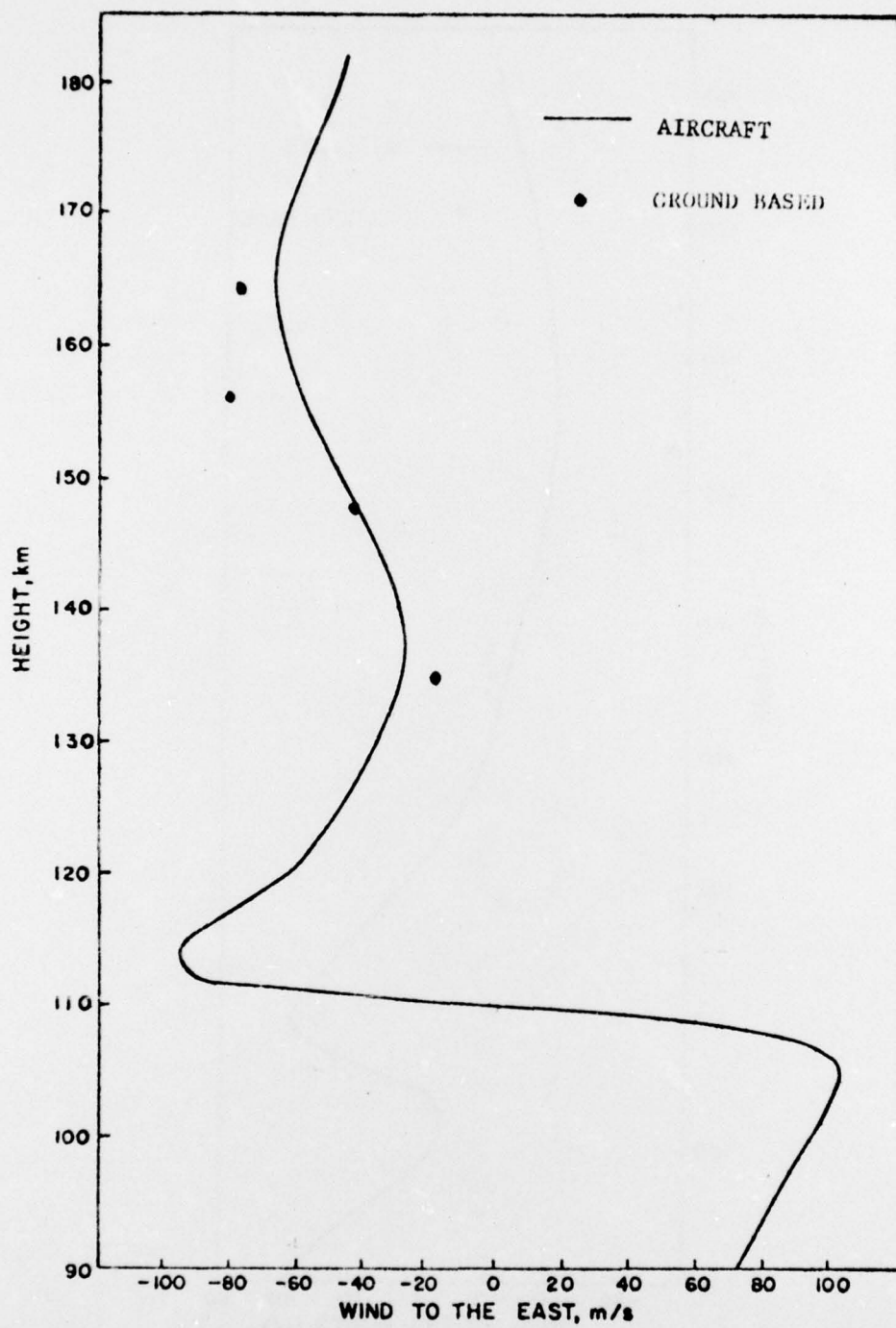


Figure 3. Height Profile of Eastward Winds From ETTY

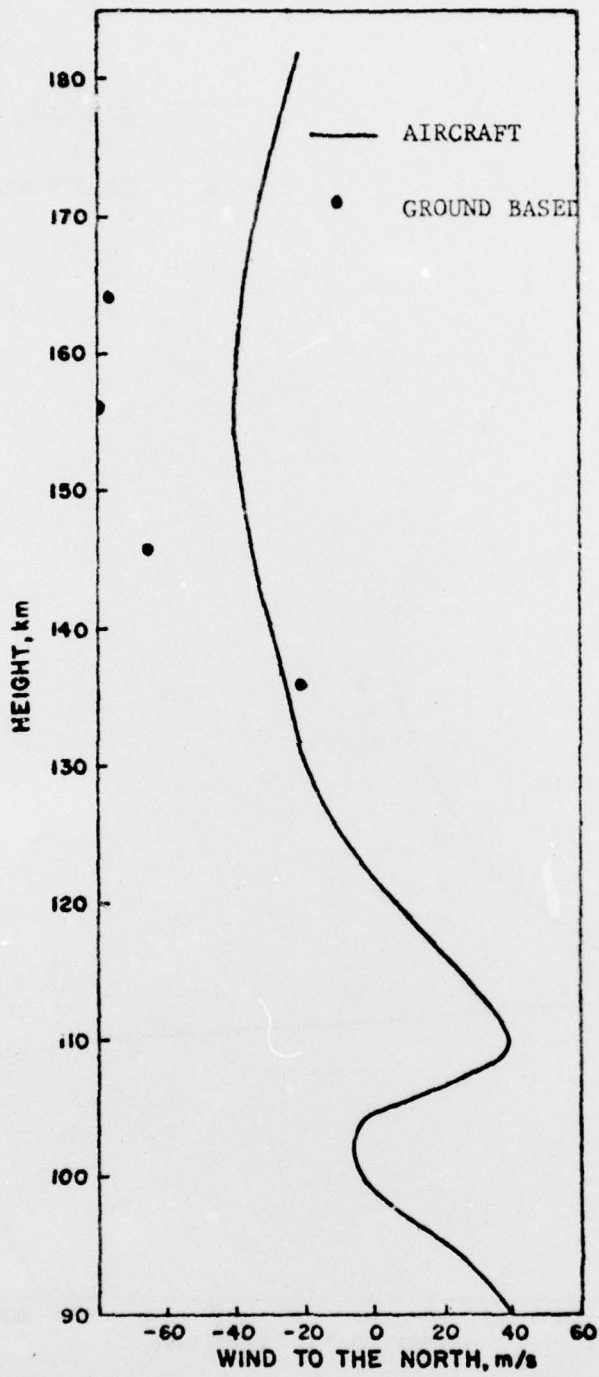


Figure 4. Height Profile of Northward Winds From ETY

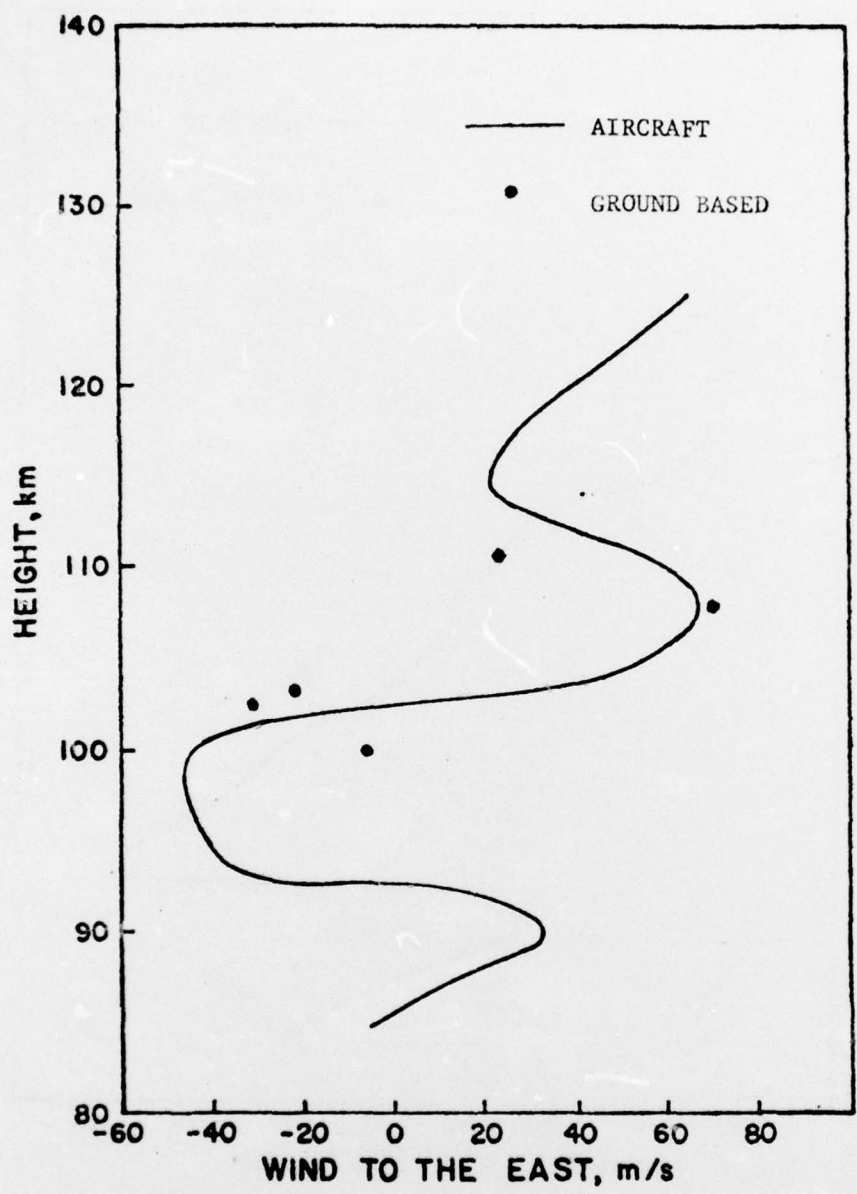


Figure 5. Height Profile of Eastward Winds From JOAN

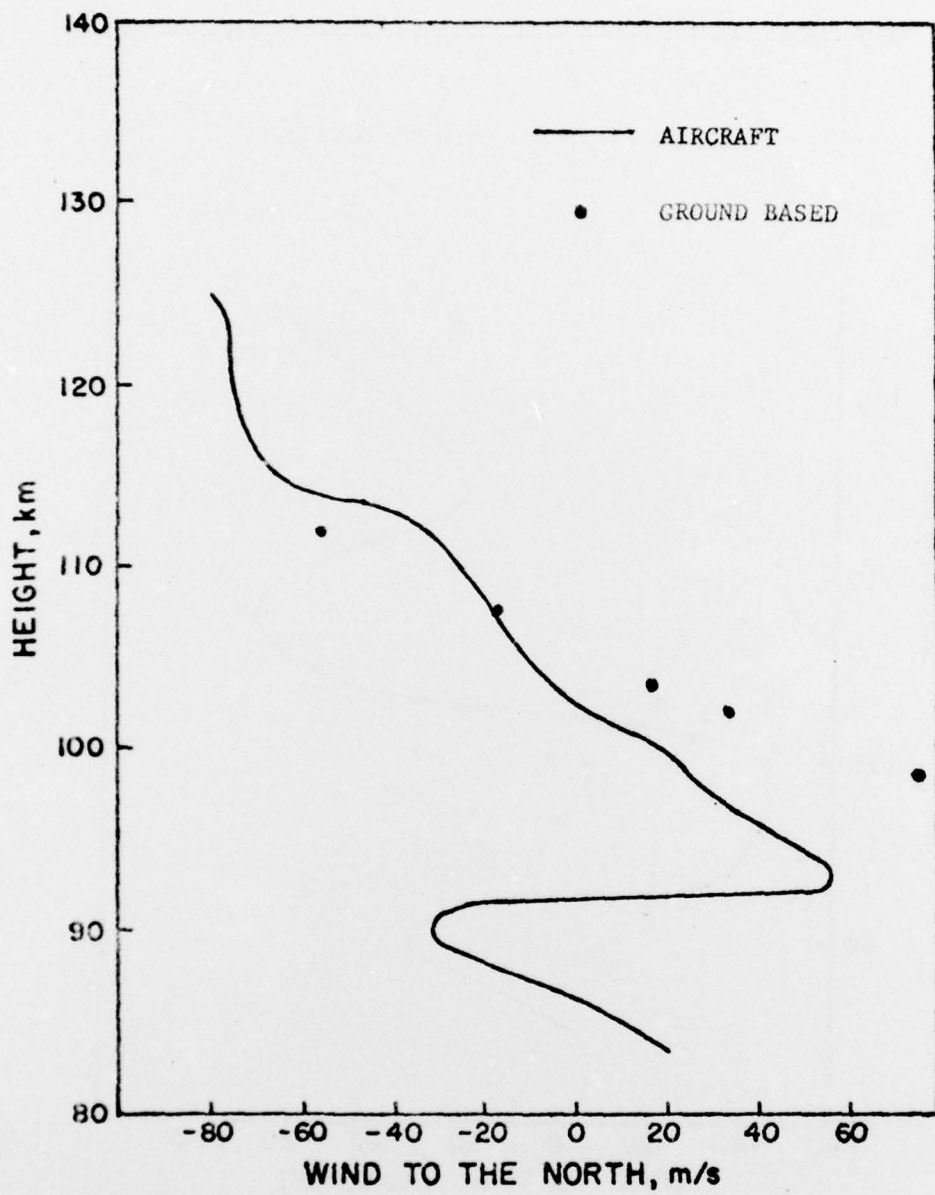


Figure 6. Height Profile of Northward Winds From JOAN

shears appear to have been underestimated from the aircraft results, again indicating that a compression of the height scale of the aircraft results is appropriate.

Conclusions.

A cursory comparison of the aircraft/groundbased data presented here does not indicate the true potential of aircraft observations. With adequate time for instrumentation of the aircraft, and the improvements in observational and analysis techniques which have been made since 1974, the accuracy of the aircraft data should almost equal that of the groundbased, but with the decided advantage that the aircraft is able to fly above the weather (cloud in particular) which imposes a major restriction on groundbased observations. An added bonus is the fact that the reduced sky background at aircraft altitudes enables photographs of daylight releases to be obtained with standard cameras and relatively simple filter systems.