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Operational oilspill trajectory models generally represent the ovement of oil on water as a series of straight line displacements, ach displacement equal to current velocity plus a wind drift factor imes a deflection adjusted wind velocity. Such representations are ased on a small number of empirical descriptions of wind induced urface movements of oil, other drifting objects, or the surface ayer of water (Stolzenbach and others, 1977, section 3). They are ot derived explicitly from analytical descriptions of the clearly omplex processes involved in the surface transport of oil. However, iven the current lack of consensus on a correct analytical descrip- ion for this process, deficiencies in available data, and procedural ifficulties in implementing existing analytical descriptions in omputer oilspill trajectory simulations, it seems probable that the mpirically derived vector addition models of surface oil movement, hough inelegant, will continue to be used for operational oilspill rajectory models.

Clearly, if one is restricted to using the simple vector addition rajectory model, one would like to use the best values for drift factor nd deflection angle given the context in which the model is to be used. mpirical work has shown that different values for these parameters are ndicated under different conditions--in particular, different values are ppropriate under different local geographies, sea states, wind onditions, and oil compositions. Unfortunately, past work has been nadequate to clearly delineate the appropriate conditional parameter alues to use given an assumed set of conditions under which an ilspill might occur. Consequently, calibration of the simple ector addition model to observed spills continues to be useful in roding the general uncertainty as to what parameter values to use n given circumstances.

The 7.7 million gallon spill of number 6 fuel oil from the tanker *Argo Merchant* off Nantucket in December 1976 provided one opportunity to assess different parameter values by hindcasting the movement of the spilled oil with the simple trajectory model. December 25 overflights following the *Argo Merchant* spill identified at 40°50' north, 68°43' west a cohesive 450 x 760 foot pancake of oil estimated to contain about a half million gallons of oil (Grose and others, 1977, p. 18, 11-13, IV-11). On December 26, this pancake was found again and drift cards were dropped on it which enabled its subsequent identification. On December 31, a satellite monitored drift buoy was dropped into the pancake. The buoy transmitted its first location report on the same day--39°57' north, 66°46' west--100 miles from where the pancake was first identified.

Hindcasts of the pancake's movement during this period were constructed using the simple vector addition trajectory model with different values for wind drift factor and deflection angle to determine the optimal values for this situation. Four sets of hindcasts were constructed, each using one of the two wind data sources and one of two current assumptions. Two sets were constructed using a current of 0.08 knots, 243° (based on drift bottle studies of the area (Bumpus, 1973) which have been used as data for operational oilspill trajectory models (Smith and others, 1976)) and two sets were constructed driving the simulated trajectory by winds alone. The two sources of wind data were *Nantucket Light Ship*, which at the time was about 25 miles south of the *Argo Merchant*, and the U.S. Coast Guard cutter *Vigilant*, which was at the *Argo Merchant* grounding site.

Optimal values for wind drift factor and deflection angle based on each set of hindcasts are shown in table 2. Previously reported values for wind drift factors have ranged from 0.8 percent to 5.8 percent (Stolzenbach and others, 1977, p. 3-81). The factors reported in table 2 --4.75 percent to 5.75 percent--are in the high end of this range, similar to those reported in field experiments by Doebler (1966). They are also reasonably in line with results of laboratory experiments by Wu (1968), which indicate wind-induced drift of surfacd water layers to be an increasing function of wind speed with the drift at 19-miles-an-hour wind speed (the highest Wu used) estimated to be 5 percent. The average speeds of winds used to drive the model for simulating the pancake trajectory were 22 knots (*Nantucket Light*) and 23 knots (*Vigilant* data).

Previously reported values for deflection angles have ranged from 0.3° left to 13.2° right (Stolzenbach and others, 1977, p. 3-81). The deflection angles reported in table 2--12° right to 24° right--are generally more to the right than those previously reported.

Response surfaces, showing the distance of predicted pancake locations from the reported location as a function of parameter value assumptions, are shown in figures 1-4 for the 4 sets of hindcasts. A qualitative assessment of these surfaces shows that model performance in the situations considered was more sensitive to wind drift factor assumptions than deflection angle assumptions over the usual range of values for these parameters. It also shows that model performance was sensitive to wind data source (despite the proximity of the 2 sources and the simultaneity of their reports) and sensitive to the current assumptions. This sensitivity can be crudely quantified by examining model performance when parameter values optimal under one combination of wind data and current are used with a different set of wind data and a different current assumption. Such an examination reveals that resulting errors in estimating the reported location of the pancake range from 13 to 23 miles. These errors are larger with a switch of wind data source than with a switch of current assumptions.

Model calibration using the *Argo Merchant* pancake had several advantages--the oil was of known type, the composition and magnitude of the pancake were similar to what may be observed in future large spills, the pancake was a clearly identifiable "piece" of oil trackable for 7 days, and wind data were quite good. In a tentative fashion, these calibration results indicate that for this type of oil under high wind speeds, using a middle-of-the-road drift factor of 3-4 percent will result in an underestimate of the speed of wind-induced oil movement. However, several of the deficiencies which mar most calibration studies were evident here also--in particular, no 3-hourly descriptions of sea state and no good information on the actual currents around the pancake were available. In light of these qualifications, calibration results based on hindcasting the trajectory of the *Argo Merchant* pancake are inconclusive and represent primarily another contribution to the stock of observed drift factors and deflection angles which might be used in simple vector addition models for the surface transport of oil.

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Table 1.--3-hourly winds used for Argo Merchant pancake hindcasts (from Grose and others, 1977, p. VII-42, Vii-44).

		Wind data source			
		Nantucket Light		Vigilant	
Date	Time	direction (degrees)	Speed (knots)	Direction (degrees)	Speed (knots)
25 Dec. 76	1000	220.	15.	230.	21
	1300	240.	20.	235.	20.
	1600	230.	18.	235.	15.
	1900	260.	12.	235.	15.
	2200	140.	4.	230.	15.
26 Dec. 76	0100	220.	6.	240.	10.
	0400	120.	15.	150.	10.
	0700	160.	15.	135.	12.
	1000	210.	15.	170.	20.
	1300	230.	10.	310.	12.
	1600	320.	20.	320.	20.
	1900	340.	30.	300.	33.
	2200	330.	40.	300.	40.
27 Dec. 76	0100	260.	30.	280.	32.
	0400	280.	30.	280.	26.
	0700	320.	26.	320.	22.
	1000	340.	25.	210.	30.
	1300	300.	30.	275.	32.
	1600	280.	30.	290.	32.
	1900	300.	35.	250.	32.
	2200	310.	35.	275.	24.
28 Dec. 76	0100	290.	25.	295.	30.
	0400	290.	20.	275.	19.
	0700	290.	3.	286.	8.
	1000	90.	10.	70.	10.
	1300	90.	18.	60.	10.
	1600	60.	20.	60.	15.
	1900	80.	18.	60.	15.
	2200	90.	16.	70.	15.
29 Dec. 76	0100	100.	18.	100.	12.
	0400	90.	20.	90.	15.
	0700	70.	18.	110.	25.
	1000	80.	12.	110.	25.
	1300	260.	20.	110.	12.
	1600	270.	27.	290.	30.
	1900	270.	32.	280.	35.
	2200	270.	32.	280.	30.

(continued)

Table 1.--continued

Date	Time	Nantucket Light direction (degrees)	Nantucket Light Speed (knots)	Vigilant Direction (degrees)	Vigilant Speed (knots)
		Wind data source			
30 Dec. 76	0100	290.	30.	285.	40.
	0400	270.	36.	280.	40.
	0700	280.	36.	280.	35.
	1000	250.	35.	280.	45.
	1300	250.	30.	280.	35.
	1600	260.	30.	270.	35.
	1900	270.	38.	270.	35.
	2200	260.	20.	270.	25.
31 Dec. 76	0100	270.	20.	280.	20.
	0400	270.	3.	300.	8.
	0700	320.	1.	300.	10.
	1000	350.	13.	310.	15.
	1300	300.	16.	320.	18.
	1600	260.	22.	280.	20.
	1900	280	20.	280	20.
	Average speed:		22.		23.

Table 2.--Optimal parameter values for the oilspill trajectory model indicated by hindcasts of the Argo Merchant pancake.

	Driving data		Optimal values	
Hindcast	Wind data source	Current assumption	Wind drift factor	Deflection
1	Nantucket Light	No current	5.25	18
2	Nantucket Light	Drift bottle current	5.75	12
3	Vigilant	No current	4.75	24
4	Vigilant	Drift bottle current	5.00	18

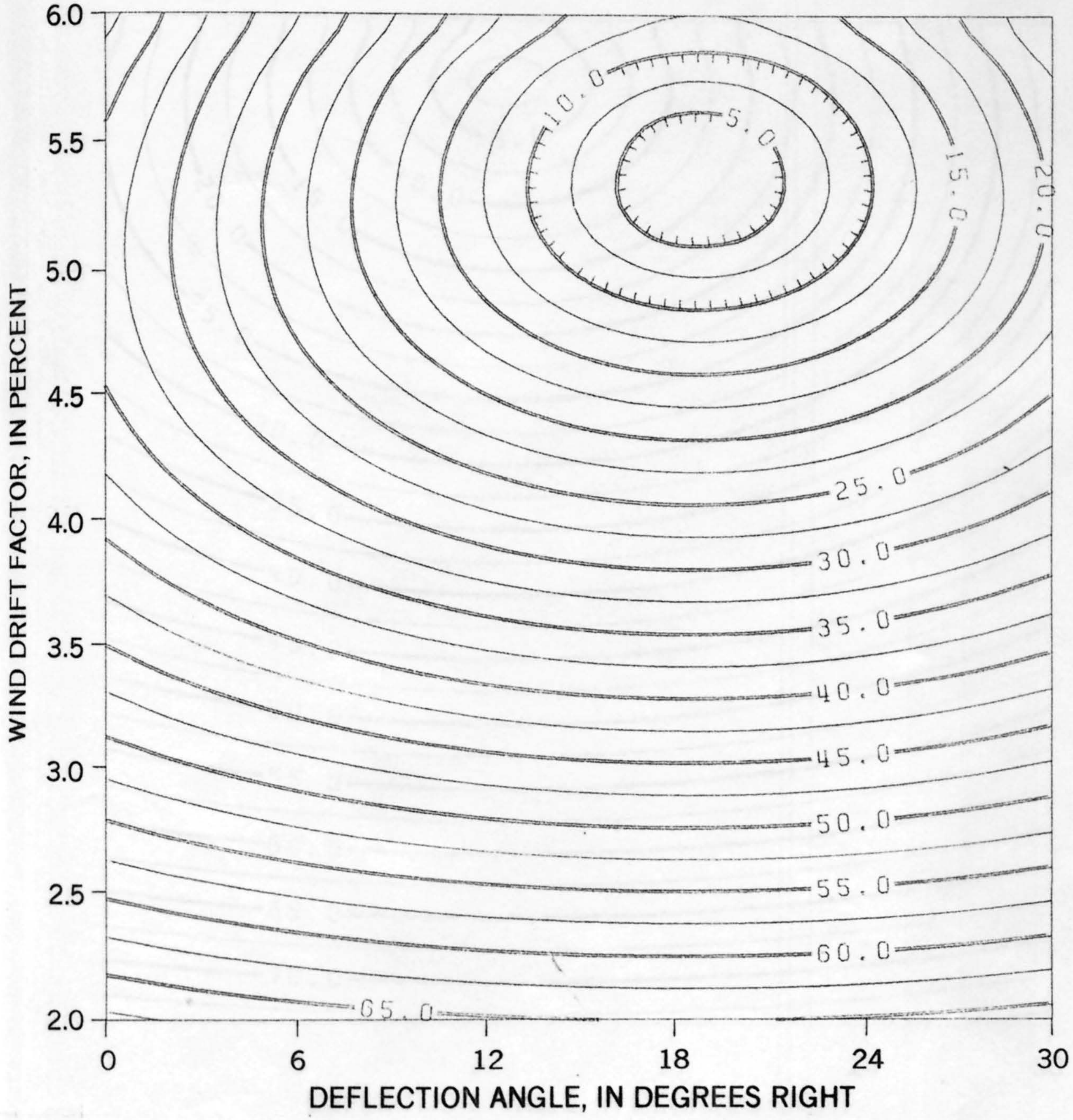

Figure 1.--Distance between predicted and reported pancake locations in nautical miles using different parameter values in the trajectory model, no assumed current, and 3-hourly winds reported from Nantucket Light.

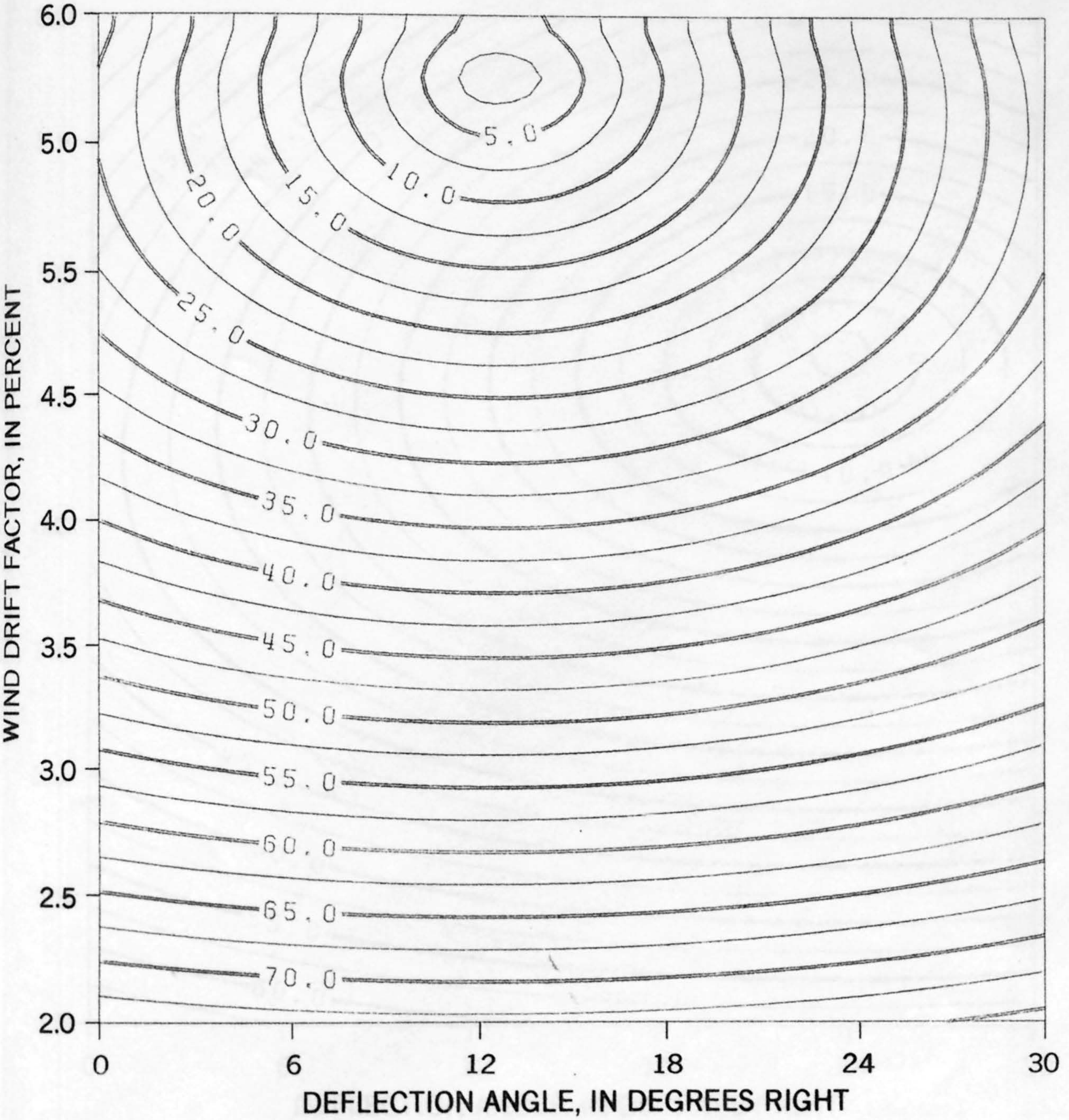

Figure 2.--Distance between predicted and reported pancake locations in nautical miles using different parameter values in the trajectory model, drift bottle current, and 3-hourly winds reported from Nantucket Light.

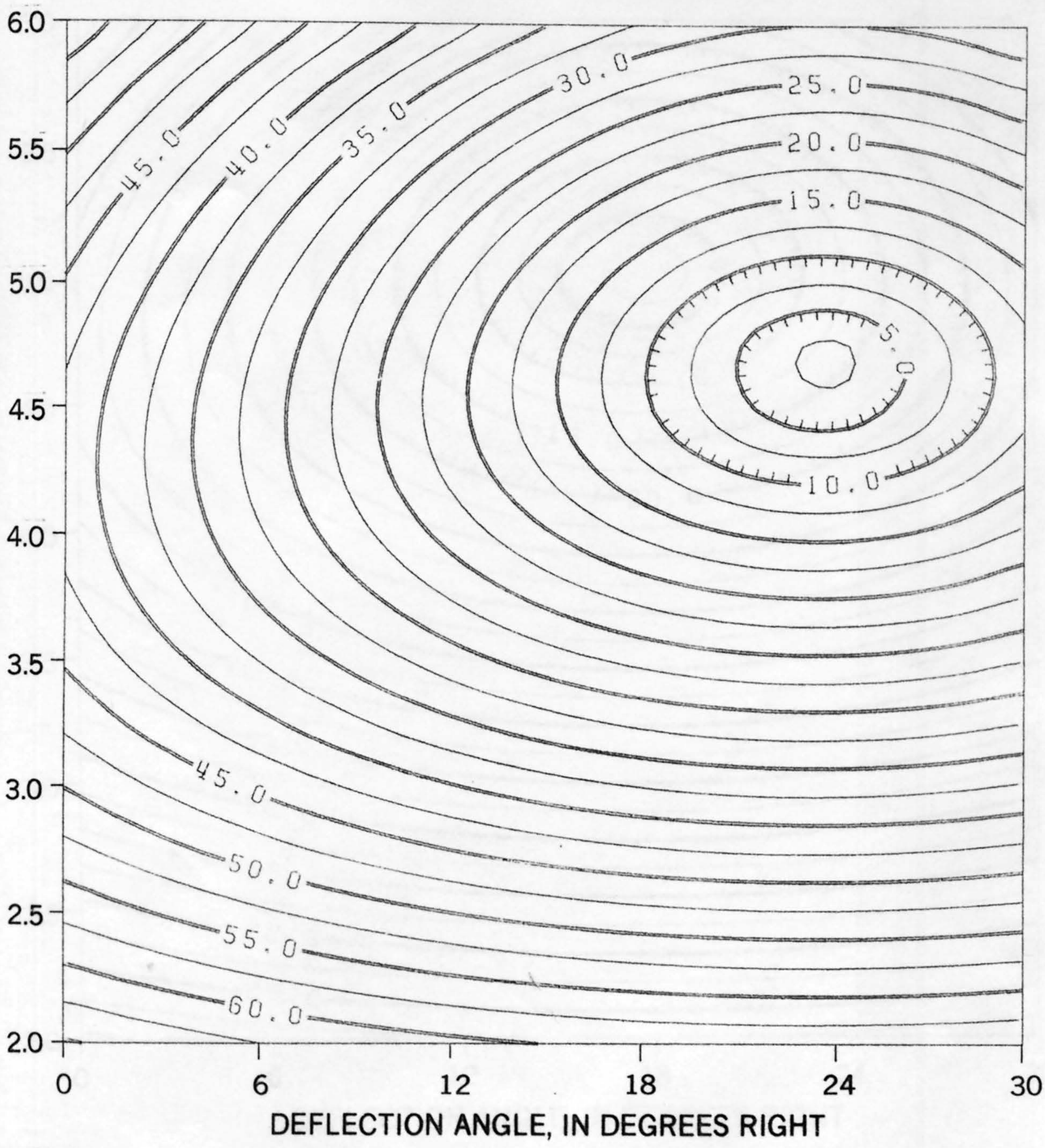

Figure 3.--Distance between predicted and reported pancake locations in nautical miles using different parameter values in the trajectory model, no assumed current, and 3-hourly winds reported from Vigilant.

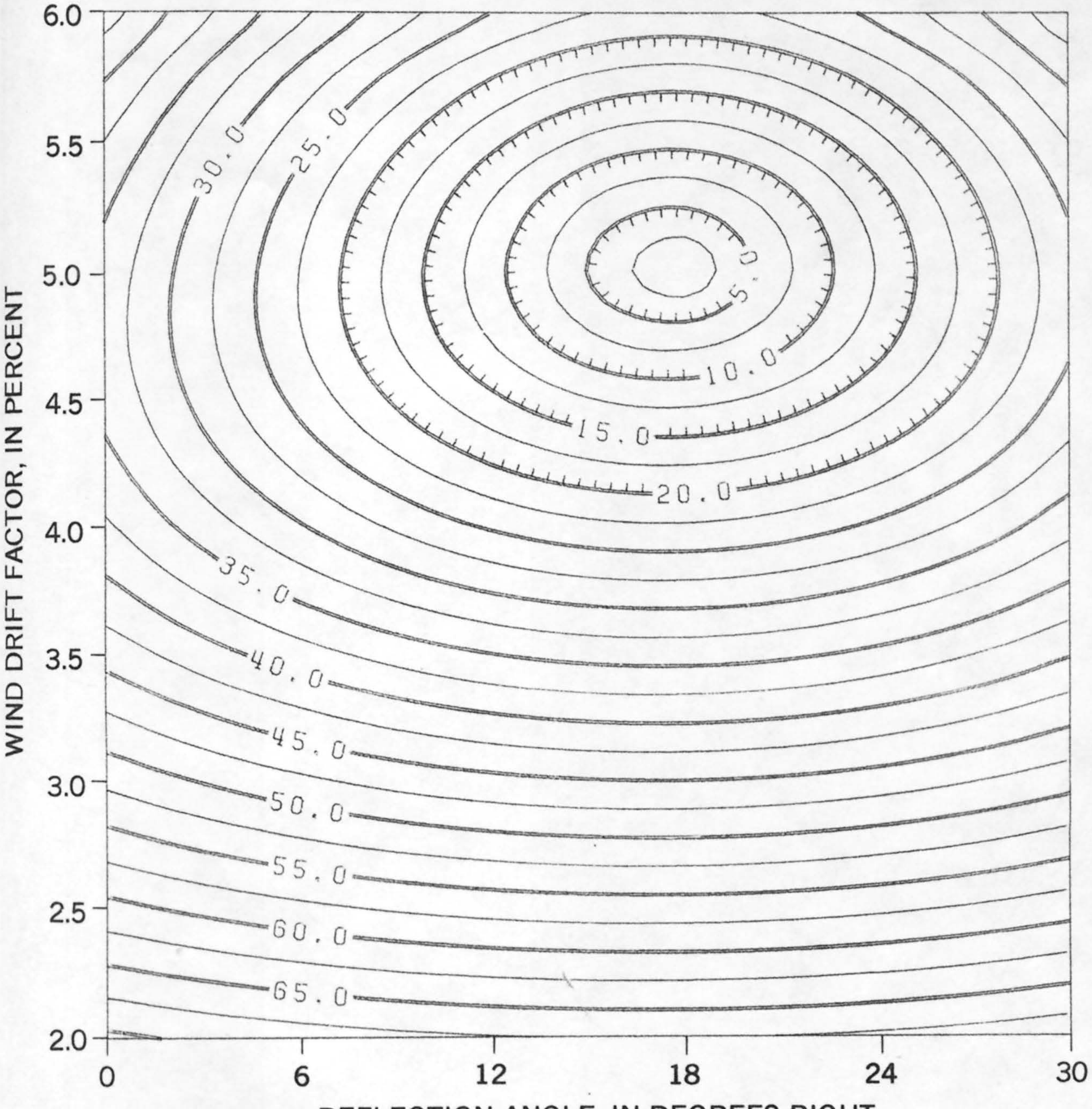

Figure 4.--Distance between predicted and reported pancake locations in nautical miles using different parameter values in the trajectory model, drift bottle current, and 3-hourly winds reported from Vigilant.