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Fish Attraction to Baits and Effects of Currents on the Distribution of Smell from Baits

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#### FISH ATTRACTION TO BAITS

### AND EFFECTS OF CURRENTS ON THE

### DISTRIBUTION OF SMELL FROM BAITS

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#### ABSTRACT

Fish are attracted to baits mainly by olfactory stimuli (smell). Past studies show that most olfactory attracted fish swim against the current, and that currents near the bottom distribute the smell from the baits. The emission of attractive olfactory stimulants from the bait decreases rapidly with time so that within an hour about 40% of the total soluable proteins (which are main stimulants) may have dissipated. The interactions between changing leaching rate of smell, current speed and direction in relation to the line, and mixing of the smell fields from adjacent baits is expected to be relatively complex. A numerical model has been designed to study these interactions.

The formulas used in the model are described, and the model is reproduced, in the Appendix. The model was used to compute smell pattern developments with time with different current speeds and directions in relation to the line of baits. Hook (bait) spacing influences the strength of the smell field as does the direction of current in relation to the line of baits. The smell field in a rotary current is greatly determined by the current direction at the time of the setting of the long line.

To validate the computed distributions of smell, current measurements at very close intervals near the bottom are required (5, 10, 20, and 40 cm from the bottom). Furthermore there is a need to know the lowest smell concentrations at which fish react in various conditions and commence the search for bait (attraction threshold).

#### 1. INTRODUCTION

Research in the last few decades has confirmed that in most fish distant location of food is by olfactory stimuli (smell) (e.g., Atema 1980). The attracting smell from baited fishing gear (long lines, pots) is distributed by currents and their associated turbulence. Thus, the long line catch might be affected by currents (e.g., speed and direction in relation to line direction). This distribution of smell with currents can be studied with numerical methods of advection as used in Hydrodynamical Numerical (HN) models. These innumerical studies might also indicate the necessity of measurements for validation.

The rate of emission of smells from baits decreases with time as the baits are leached out (Solemdal and Tilseth 1978). The interaction between changing leaching rate and changing currents (e.g., tidal currents) is expected to result in complex smell distribution patterns in space and time (smell fields), which would affect the attraction of fish to the bait.

This paper reviews the mechanism of fish attraction by smell emitted from baits, and describes the methods and results of a study of the distribution patterns of smell as affected by different near bottom currents. The results are expected to find some application in long line and baited trap fisheries, indicating such factors as the effect of varying the height of bait above bottom, optimizing the direction of long line setting in relation to current, and what might be the optimum soak time. Above all, the studies with the model should indicate what additional research and measurements must be conducted.

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# 2. FISH ATTRACTION BY BAITED GEARS AND DISTRIBUTION OF SMELL FROM BAITS

In fishing with any kind of baited gear, the primary purpose of the bait is to attract fish to the location of the gear, and, subsequently, to entice them to enter the trap or to bite the hook. The bait, therefore, has to emit stimuli which are attractive to the target fish, at levels of intensity sufficient to induce the fish to search for the source of smell.

The bait also has to remain intact (i.e., stay on the hook) and continue to emit stimuli for a period long enough to permit the attracted fish to find the bait.

In the near field, where the process of capture takes place, vision may also be of great importance, but attraction beyond a few meters is probably nearly always based on olfactory stimuli (e.g., Kleerekoper 1969). For certain species of fish with less developed olfactory organs, however, chance foraging also will be of significance in their feeding behavior (Pipping 1926, 1927).

#### Bait attraction

In the following we shall assume that <u>olfactory stimuli alone</u> are causing the far field attraction of a bait. Since fish have been found to be able to detect chemicals at extremely low levels of concentration (Atema 1980), we shall further assume that <u>the presence</u> of a bait stimulus in the water inhabited by a fish will always be detected.

The bait scent or smell, however, has to compete with the large array of other stimuli to which the fish is subjected at the time. The reaction to the

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awareness of a new smell will, therefore, be dependent on its relative attractiveness to the fish, which may be a function of many factors, such as physiological state, food and feeding conditions, previous diet, time of season or day, etc. (e.g., Fernö et. al. 1981, Solemdal et. al. 1983). The <u>level of intensity</u> of the bait smell will be important. Probably it must exceed a certain threshold before the fish reacts by starting to search for the bait, and it is conceivable that this <u>reaction threshold</u> may be modified by the duration of stimulation.

In conventional cut long line bait (e.g., herring, mackerel, squid), water soluable proteins have been found to be attractive olfactory stimulants. These are rather quickly dissolved and dissipated in the water, some experiments indicating emission rates of as much as 40% of the total contents of soluable proteins being dissolved within an hour at normal ambient sea water temperature (Solemdal and Tilseth 1978).

The bait stimuli is not emitted at a constant intensity, but rather at a quickly (in the matter of minutes) increasing and, thereafter, gradually decaying rate. Most likely, the emission has already culminated by the time the long line or pot has sunk to the bottom in offshore fishing.

For baits placed on the sea bed, the stimuli are dissipated by the movements of water close to the bottom. UW-TV observations of fishing gear suggest that near bottom currents are weak but variable, both in velocity and direction, even when there is a clear main direction of water transport. We may, therefore, assume that the stimuli from a point source on the sea bed are dissipated downstream along the bottom within an arc, of say 20-40°. Horizontal velocities very near the bottom are probably seldom above a few cm/sec in relevant fishing locations, which is well below endurance swimming speeds for the species and sizes of fish caught by baited fishing gears.

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Vertical dissipation of bait stimuli is probably mainly caused by near bottom turbulence.

Because of the quck decay in stimuli emission rate at very slow bottom current velocities (and/or at small arcs of dissipation), the emission decay rate may exceed the rate of stimuli intensity decrease caused by geometrical spreading. In such cases, fish attracted by the bait at a distance would swim into decreasing stimuli intensities whichever direction they are heading. While steep intensity gradients and distinct chemical trails provide sufficient information for localization, the gradients in the stimuli farfield of a baited gear are normally so weak that other non-chemical cues are required for localization of the baits (Kleerekoper et. al. 1975). Knowledge and understanding of the mechanisms in food localization of fish are as yet rather incomplete, but it is believed that fish are able to sense the direction of water movement and locate the source by swimming upstream when aroused by smell stimuli (Atema 1980).

The number of fish attracted to the bait will be a function of fish density, area of attraction, and the variability in attraction rate within this area. The total number of fish attracted to the bait, when plotted against soak time will, therefore, form a sigmoid curve, ascending slowly during the early part of the soak, then at a gradually steeper rate which falls off again as the rate of attraction decreases.

The time required for the stimuli to be dispersed below the attraction level plus that required for the most distant attracted fish to get to the bait, is the maximum soak time required to attract fish. Unless fish from outside move into the stimuli area, any further soak time will be non-productive, even if the bait is still emitting stimuli.

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#### 3. EFFECTS OF CURRENTS ON THE DISTRIBUTION

#### OF SMELL FROM BAITS

#### 3.1 The numerical model

Molecular diffusion in the water is very slow and, therefore, the main mechanism for the distribution of smell from bait is current and turbulence (eddy diffusion) associated with it.

The currents near the bottom are weak, but the current speed increases rapidly with distance from the bottom (Figure 1). This increase with height above the bottom depends on the roughness of the bottom and current speed in the water mass above. The increase of current speed with increasing distance from the bottom would affect the distribution of smell from bait which is hung at different heights above the bottom (e.g., in traps). Unfortunately no current measurements in very short distances over the bottom (few cm) are at hand at present.

Over the continental shelf, and especially in shallower waters, tidal currents dominate. These currents can be diurnal or semidiurnal; the change of direction and speeds is usually ellipse-like. In water shallower than about 30 meters, wave motion (particle movement in below-surface layers due to waves) can reach the bottom and affect the distribution of smell from baits. The easiest way to study the complexities of smell distribution from bait is with a numerical model with spatial resolution.

In the present study the distribution of smell from bait was simulated with a numerical model where different speeds, directions, and different source strengths were prescribed.

Experiments show that the amount of smell emitted from the bait decreases rapidly with time. This decrease was simulated with Formula 1.

$$S_{t} = \frac{1}{at+1} S_{0}$$
(1)

where  $S_t$  is the strength of the smell at the source at time t,  $S_o$  is the initial strength and a is a numerical constant. Two different values were assigned to a and the results are shown in Figure 2.

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Figure 1.--Schematic profile of current speed near bottom.



Figure 2.--Simulated decrease of smell emission from bait with two different decay constants.

In smell distribution simulation experiments, the amount of smell at any given time was released either at a single point to study its distribution in detail, or in a row of points 2 to 8 meters apart to simulate baited hooks in a long line with different hook spacing.

The current speed was simulated with prescribed u and v components and horizontal turbulence was simulated with the fluctuations of these components. The unidirectional flow was simulated with Formulas 2 and 3.

$$U = U_{b} + U_{a} \cos (\alpha_{1}t)$$
(2)  
$$V = V_{b} \cos (\alpha_{1}t + \kappa_{1})$$
(3)

where  $U_b$  and  $V_b$  are prescribed u and v components of the current,  $U_a$  is the magnitude of fluctuation of u component and  $V_b$  is a small fraction of  $U_b$  (13% in the programme in Appendix, this fraction growing with increasing  $U_b$ ). The  $V_b$  component is for the simulation of horizontal eddy diffusion of smell due to fluctuations in current. If main current direction is desired in v direction, the Formulas 2 and 3 change position.  $\alpha_1$  is the phase of current fluctuation (changing either 1 or 2 degrees per second (6 or 3 minute periods)); t is time in seconds, and  $\kappa_1$  is phase lag (e.g., 45°).

A rotating tidal current was simulated with Formulas 4 and 5.

$$U = U_{b} \cos (\alpha_{2}t + \kappa_{2})$$
(4)  
$$V = V_{b} \cos (\alpha_{2}t + \kappa_{3})$$
(5)

where  $\alpha_2^{}$  is 0.008 degrees per second,  $\kappa_2^{}$  is 90° and  $\kappa_3^{}$  is 180°.

The advection of smell was computed with an "upcurrent differentiation" method. First, the gradient of smell ( $S_v$  of  $S_u$ ) in upcurrent direction was computed:

U positive:

$$S_u = (S_{n,m} - S_{n,m-1})/d$$
 (6)

U negative:

$$S_u = S_{n,m} - S_{n,m+1}/d$$
 (7)

where n and m are the coordinates of grid points and d is grid size (in cm).

The computation of the gradient of S in v direction  $(S_v)$  is analogous to Formulas 6 and 7.

The concentration of S in any grid point was thereafter computed:

$$S_{n,m} = S_{n,m} - (t_d | U | S_u) - (t_d | V | S_v)$$
 (8)

where  $t_d$  is length of time step (in seconds) and U and V are corresponding components of currents.

Additional horizontal diffusion was computed with a smoother:

 $S_{n,m} = \alpha_3 S_{n,m} + \beta (S_{n+1,m} + S_{n-1,m} + S_{n,m+1} + S_{n,m-1})$ (9) where  $\alpha_3$  was 0.80 and  $\beta = (1 - \alpha_3)/4$ .

The conservancy of the diffusion and transport formulas was computed after each smoothing.

The grid distance was selected either as 1, 2, or 4 meters and the corresponding time step used was either 30 or 60 seconds, depending on grid size.

In some runs, the vertical height or thickness of the smell distribution layer was made to thicken with distance from the bait (simulating vertical eddy diffusion), and the amount of smell (S) was distributed in this thickening layer, resulting in lower concentrations with distance from source.

#### 3.2 Distribution of smell from single bait

Some results of the computations with the above described model are discussed below with reference to current speed and its direction in relation to the direction of the long line. The initial strength of smell emission was arbitrarily selected at 10 units in the first 30 seconds. The emission decreases with time as shown in Figure 2. Figure 3 shows the distribution of "smell field" after 1 and 2 hours of soak time, with a constant current speed of 0.2 cm/sec. After two hours, the "nominal field strength 10" (the contour of the 10 units of "smell") has reached 22 meters from the bait, and the width of the "10 field" is about 12 meters.



Figure 3.--Distribution of smell from a bait with current speed of 0.2 cm/sec; laminar flow; A - after 1 hour soaking, B - after 2 hours soaking. (10 units of smell emitted in every 30 seconds.) With a current speed of 0.6 cm/sec (Fig. 4) the length of the "10 field" is about 32 meters after one hour and its width about 6 meters (Fig. 4A). After two hours, the maximum width of the "10 field" remains about the same, but the length is now about 43 meters from the bait, with lower concentrations in between the bait and this higher concentration area. This feature is caused by the rapid decrease of smell emission with time (Fig. 2). The maximum width of the "10 field" remains about 6 meters.

With higher current speeds (1.4 cm/sec, Fig. 5A) the smell field gets longer and wider, but its concentrations lower (observe the increased grid distance in these computations). The width of the field increases slower than its length (i.e., the "10 field" width with current speed of 1.4 cm/sec is at maximum 12 meters at about 55 meters from the bait). The width of the smell field is an important factor in estimation of optimum hook spacing as it determines the strength of the smell field by overlap of fields from adjacent baits (Figs. 8 to 20). After two hours (Fig. 5B), the center of secondary maximum is about 105 meters from the bait. The smell field strength between this secondary maximum and at the bait is only slightly more than half the strength of the secondary maximum.

The occurrence of the higher concentration of smell away from the bait raises the questions whether fish can find the hook (bait) and are attracted to it in such cases, and how does the smell stimuli existing in the environment (e.g., benthos) interact with the search for the bait?

Rotary tidal currents prevail on the continental shelf. Therefore, computations of the distribution of smell from a single bait were made with rotary current (rotation period 12 hours). At time 0 the current was running to east (right) with U = 0.65 cm/sec. Figure 6 shows the smell distribution after 2 hours and Figure 7 after 3 hours. Due to the rotational effect, the smell field becomes c-shaped, with higher concentrations some distance from the bait, resulting from the decreasing emission rate of the smell.

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Figure 4.--Distribution of smell from a bait with current speed of 0.6 cm/sec; laminar flow; A - after 1 hour soaking, B - after 2 hours soaking. (10 units of smell emitted in every 30 seconds.)



Figure 5.--Distribution of smell from a bait with current speed of 1.4 cm/sec; laminar flow; A - after 1 hour soaking; B - after 2 hours soaking. (10 units of smell emitted in every 30 seconds.)

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Figure 6.--Smell field in a rotary current after 2 hours (initial flow to the right, 0.65 cm/sec, full rotation in 12 hours).

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Figure 7.--Smell field in a rotary current (same as in Figure 10) after 3 hours.

#### 3.3 Distribution of smell from a line of baits in unidirectional current

As the smell field expands laterally downcurrent due to turbulence (eddy diffusion), it is expected that the smell fields from individual baits would overlap. Computer runs with 6 and 11 baited hooks in a line with 2 and 4 meters hook spacing were made, in which an 0.6 cm/sec current was perpendicular to the line. Figure 8 shows the resulting smell field after 1 hour from 6 baited hooks 4 meters apart. The second maximum smell field concentration is about 20 meters downcurrent of the baits and is somewhat stronger than the field from a single bait (Fig. 4A). The smell field from a line of baits 2 meters apart after one hour soak time in 0.6 cm/sec currents is given in Figure 9. Although the second maximum of the smell field is at the same distance from the hooks as in Figure 8 (ca. 20 meters downcurrent), its strength is about twice that in Figure 8. Thus, closer spacing of hooks might better attract fish to the bait by creating a stronger smell field.

After two hours soaking time (Figures 10 and 11), the center of the maximum smell field is about 45 meters downcurrent in both bait spacings. The smell field between this maximum and the baits is about one-third of the strength of the maximum field strength. The field strength with 2 meters hook spacing is about twice as strong as that with 4 meters spacing.

The results of the computations of smell fields presented in Figures 3 to 11 were made assuming laminar flow (no turbulent eddy exchange in vertical direction). In nature, the flow is likely to be turbulent also in a vertical direction to some degree, and the layer in which the smell is distributed near the bottom will increase in thickness with the distance from the bait which decreases concentrations of smell. Some outputs from the computations with increasing layer thickness are shown in Figure 12, with other conditions (current speed and bait spacing) being the same as in Figure 10. Comparing Figure 12 with Figure 10, we can notice that

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Figure 8.--Smell field from a line of 6 baited hooks, 4 meters apart, after 1 hour. 0.6 cm/sec, laminar flow.



Figure 9.--Smell field from a line of 11 baited hooks, 2 meters apart, after 1 hour. 0.6 cm/sec, laminar flow.

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Figure 10--Smell field from a line of 6 baited hooks, 4 meters apart, after 2 hours. 0.6 cm/sec, laminar flow.

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Figure 11--Smell field from a line of 11 baited hooks, 2 meters apart, after 2 hours. 0.6 cm/sec, laminar flow.



Figure 12--Smell field from a line of 6 baited hooks, 4 meters apart, after 2 hours; 0.6 cm/sec, layer thickness increasing with distance from the hooks. the second concentration in Figure 12 has nearly disappeared as the result of increased thickness of the layer with distance from bait, and the field strength is rather uniform between bait and about 45 meters from it in Figure 12. The "10 smell unit" concentration field has also shortened as a result of thickening of the smell-containing layer.

#### 3.4 Distribution of smell from a line of baits in rotary current

The distribution of smell field from a line of 6 baited hook, 8 meters apart, in a rotating current (initial current to the right, U=0.65 c/sec, clockwise rotation) is shown in hourly intervals in Figs. 13 to 16. At the prescribed current speed, the center of the second maximum in smell field starts to develop in about an hour 16 meters from the hooks (Fig. 13). After two hours, the center of this maximum is about 34 meters from the hooks and the field nearer to the hooks has considerably lower intensity (Fig. 14). After three hours, this 'maximum field'' has about the same intensity, but is at about 42 meters from the hooks (Fig. 15). The near field of smell has decreased to about half of the value at the smell maximum. After three hours, the current is parallel to the line of hooks, and the concentration of smell starts to build up there due to overlap. After four hours, concentration of smell has built up along and near the line of baits (Fig. 16). However, there remains a secondary maximum of smell at about 35 meters from this line at this time which would move slowly toward the line of baits during the next two hours.

In a second set of numerical experiments (rotary current with the same velocity and the same hook spacing as in Figs. 13 to 16), the current at time 0 was parallel to the line of hooks and turned clockwise (Figs. 17 to 20). After one hour soaking time, the higher concentration of smell is to the left of the line (Fig. 17). The concentrations are two and a half times as high as those in corresponding Figure 13 when the current was initially running perpendicular to the line. These high concentrations are the result of overlap

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Figure 13--Smell field from a line of 6 baited hooks, 4 meters apart, in a rotary current, after 1 hour, (initial current perpendicular to the line, 0.65 cm/sec, turning clockwise).

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Figure 14--Smell field in a rotary current (as in Fig. 13) after 2 hours.



Figure 15--Smell field in a rotary current (as in Fig. 13) after 3 hours.

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Figure 16--Smell field in a rotary current (as in Fig. 13) after 4 hours.

Figure 17--Smell field from a line of 6 baited hooks, 4 meters apart, in a rotary current, after 1 hour, (initial current longitudinal to the line, 0.65 cm/sec turning clockwise).

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Figure 18--Smell field in a rotary current (as in Figure 17) after 2 hours.

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Figure 19--Smell field in a rotary current (as in Figure 17) after 3 hours.

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Figure 20--Smell field in a rotary current (as in Figure 17) after 4 hours.

of smell fields from several baits. After two hours, the center of high concentration of smell has moved farther to the left and is about 20 meters from the line (Fig. 18). After three hours of soak time (Fig. 19), the center of the field of maximum smell is about 38 meters from the line, the concentrations being about one-third higher than on corresponding Figure 15. After four hours (Fig. 20), the concentration field has moved farther away from the line. However, the smell concentrations between the baits and the high concentration field are about one-fourth of the high concentrations, and are considerably lower (about half) than in Figure 16.

Properly designed experimental fishing is required to determine which of the setting times in respect to tidal currents (i.e., initial current perpendicular or longitudinal to the line) is more beneficial for attracting the fish to the bait and influencing the catch. In cases where the current was initially perpendicular to the current, the secondary maximim smell field at some distance from the line is weaker than in cases where the current was in the same direction with the line during the setting. However, in the former case, another higher concentration of smell forms after about three hours of setting along the long line when the tidal current has become parallel to it. This higher smell concentration at the baits might be beneficial in helping the fish find the bait.

#### 4. CONCLUSIONS

Olfactory stimuli from the baits (smells) are the main means of distant attracting of fish to the bait. The reaction threshold of the fish to different stimuli (smells) is at present not well known.

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Water soluable proteins have been found to be the attractive olfactory stimulants of long line baits. These proteins are rapidly leached from the bait (in the first few hours).

In an unidirectional steady current, perpendicular to the line of baits, a smell field maximum forms within an hour at some distance from the bait; this distance depends on current speed. The smell concentrations between this maximum and the bait are considerably lower than the smell maximum. This condition is caused by the rapid decrease of the amount of smell emitted by the bait per unit time. If the layer in which smell is distributed thickens with the increase of the distance from the bait, the concentrations in the "maximum smell field" become lower. In long lining, the smell field strength increases with the decrease of hook spacing, caused by overlap of smell from adjacent baits.

In rotary (tidal) current, considerable differences occur in the strength of the smell field and in the distance of the smell field maximum from the line, depending on the direction of the current during the setting of the line. The strongest smell field is achieved if the current runs parallel to the line during the setting. On the other hand, when the line is set across the current, relatively high stimuli intensities near the line are maintained for a longer period.

These numerical simulations indicate the need for several empirical studies: First, we need to measure current speeds at close distances above the bottom. Second, we need to know the approximate strengths of smell from different baits which excite fish to search for the bait under varying conditions, (i.e., the attraction threshold values of bait smell), and how this is modified by other environmental smell stimuli from natural food (e.g., from benthic animals).

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Furthermore, several other conclusions on the distribution of smell field obtained in this numerical study require experimental verification, especially the effect of turbulence near the bottom and the corresponding increase in the thickness of the layer in which the smell is distributed. Fishing experiments with different line directions in relation to current direction during the setting time, would also be desirable, provided the dirunal feeding cycles, which might interact with these experiments, are taken into consideration.

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#### Appendix |

#### SIMULATION MODEL PHEROM FOR COMPUTATION

#### OF DISTRIBUTION OF SMELL FROM BAIT

The formulas used in the simulation are described in the text. The input parameters to the model and symbols used therein are given in the following list.

The program allows several options for running, which are set with indices in the beginning of the program. Thereafter various auxiliary constants are set.

The current speed (u and v components) are prescribed in four different sets, which can be chosen with the indices KU and KR. The initially prescribed current speeds can be augmented at the end of the program so that results are given for four different sets of speeds in one run.

The selectable current direction sets are: 1) perpendicular to the line (KU=1), parallel to the line (KU=2), at 45° angle to the line (KU=3), and a rotating semidiurnal tidal current (KR=2). The initial current speeds are described with U(U1) and V(V1) components, and the currents are allowed to fluctuate in speeds with a fluctuation amplitude of 25% of prescribed current speed and with a 3-minute period of fluctuation (FAF = 2° per second). Furthermore, a slow fluctuating cross-current is prescribed for the current perpendicular and longitudinal to the line, the fluctuation of which is offset from the main component by 45° (TCAP). The rotary current changes direction 0.008° per second.

The grid size is defined either as 1 meter (GR=1), or 2 meters (GR=2). The smell from the hooks (usually in column 15) is emitted either from one hook only (KL=1) or from 6 hooks in a line (KL=2) (also 11 hooks used).

The advection of the smell is computed with "upcurrent differentiation" method (see text), whereafter a diffusion is applied (as a smoother) and the

conservation of the smell is checked (no time decay is allowed except a decay of leaching from the bait).

An option to compute the change of concentrations due to increasing thickness of the turbulent layer from the source (bait) is given next in the program. In the program listing given here, the layer is allowed to thicken 15% per 10 meters.

The concentration fields are printed in prescribed time intervals. At the end of computations (3 hours real time), the speeds are augmented and the program repeated.

The two appended subroutines are for diffusion (smoothing) and for printing of outputs.

LIST OF INPUT PARAMETERS AND SYMBOLS USED IN THE MODEL

1. Control parameters

КА	- "Layer thickness" index; 1 - laminaraflow; 2 - layer thickness
	increasing with distance from bait.
KF	- Current fluctuation index; 1 - period 3 min., FAF = 2°/sec;
	2 - period 6 min., FAF = 1°/sec.
KG	- Grid size index; 1 - grid size 1 m; 2 - grid size 2 m. (Note:
	DL is grid size; if current speed is >1 cm/sec, grid size is
	raised to 2 m).
KL	- Single bait or line index; 1 - single bait; 2 - line of 6 or 11
	baits in line.
KR	- Unidirectional or rotating current index; 1 - unidirection; 2 -
	rotating tidal current. (Only one quarter of rotation is
	computed.)
кт	- Time step index; 1 - 30 sec.; 2 - 60 sec. (Note: the frequency of
	the call for smoothing (IAC) and output printing (IPR) are time
	step dependent.)
KU	- Current direction index; 1 - U direction; 2 - V direction; 3 -
	current at 45° angle to line.
2 Sumb	als for inputs and computed parameters (* denotes inputs)
2. <u>Symbo</u>	STS for hiputs and computed parameters (* denotes hiputs)
*AD0	- Phase speed of the rotation of current (0.008 deg/sec).
*AE	- Smell decay factor (a) (0.0012).
*AKADI	- Phase lag of the rotation in radians (90 deg. lag).
ALP	- Phase speed parameter in radians.
*ALPHA	- Smoothing parameters.
*APARP	- Phase lag of the rotation in radians (180 deg. lag).
AROT	- Phase speed of rotation in radians.

BET	-	(1 - ALPHA)/4.
*CON	_	Conversion factor from degrees to radians (0.0174533).
*CTR	_	Parameter for computation of increase of layer thickness from
		bait (0.015) (input after statement 60).
DIS	-	Intermediate for computation of distance from bait.
*DL	-	Grid size, cm.
*FAF		Current fluctuation period parameter (degrees per second).
*IAC	-	Parameter determining the interval of time steps when smoothing
		(diffusion) subroutine is called.
*IPR	-	Parameter determining the interval of time steps when output
		(printing) subroutine is called.
1S(N,M)	-	Integer value of S (for printing).
ITC	-	Time step counter for smoother.
ITOP	-	Time step counter for output.
*KS	-	Counter for the number of different current speeds computed in
		one run (input in statement 72).
м	-	Grid index (M direction, i.e., rows).
*ME	-	Number of grid points in row.
N	-	Grid index (N direction, i.e., columns).
*NE	-	Number of grid points in column.
PF(N,M)	-	Field for computation of concentrations due to increased "layer
		thickness".
RRC	-	Factor of concentration decrease due to increase of layer thickness.
S(N,M)	-	Smell concentration field.
SH	-	Intermediate, smell gradient in u direction.

*S0	- Initial strength of smell.
SUA	- Intermediate for summation (smell before advection).
SUS	- Intermediate for summation (smell after advection).
SV	- Intermediate, smell gradient in v direction.
т	- Time counter (summation).
*TCAP	- Phase lag in radians.
*TD	- Time step, in seconds.
*TF	- End of computations in seconds.
*TURC	- A parameter for simulation of turbulent diffusion (0.13).
U	- U component of the current
UA	- Magnitude of the fluctuation of U component.
*U <b>I</b>	- U component of the current (prescribed)(cm/sec).
UI	- Intermediate (SUA/SUS).
V	- V component of the current.
VA	- Magnitude of the fluctuation of V component.
*V1	- V component of the current (prescribed) (cm/sec).
VALE	- S value "left" (S(N,M-1)).
VALO	- S value "below" (S(N+1,M)).
VARI	- S value "right" (S(N,M+1))
VALLE	- $S$ value $Uup!! (S(N-1 M))$

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č		KG-GRID SIZE 1-1H;2-2M	0000050
C		KT-TIME STEP 1-30 SEC. 2-60 SEC.	0000061
C		KF-FLUCTUATION PARAMETER (FA); PERIOD 3 MIN, KF=1, FA=2.	0000071
С		$6 \text{ MIN}_{P} \text{KF} = 2 _{P} \text{F} _{A} = 1 _{\bullet}$	3800030
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č		KS-SPEED COUNTER FOR 4 DIFERENT SPEEDS	0000140
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GC TC 18         00002           15 UI=0.14         00002           VI=-C.14         00002           C 00 C 25*VI         00002           GC TC 18         00002           VI=0.25*VI         00002           ADD=0.400         00002           AKDT=ADC+CCN         00002           AKDT=ADC+CCN         00002           AKDT=ADC+CCN         00002           AKDT=ADC+CCN         00002           GC TC 18         00002           GC TC 18         00002           GC TC 18         00002           GC TXXXXX         00002           IDC 11 M=1,20         00003           SC XXXXX         00003           ID TIC=ITC+1.         00003           ID TIC=ITC+1.         00003           ID TIC=ITC+1.         00003           GC TX			V A=0.25 * V I		00002
15       L1=0.14       DC002         V1=-0.14       DC002         VA=0.25*VI       CC002         GD TG 18       D0002         V1=0.65       DC002         V1=0.65       DC002         V1=0.25*VI       CC002         VA=0.25*VI       CC002         VA       CC002         VAXXXX       CC002         C       XXXXX       CC002         ID=200.*CCN       CC002         IIC=0       CC002         IIC=0       CC002         IIC=1       CC002         IIC=1       CC002         III P=1.75       C0003         III CONTINUE       CC003         C       XXXXX       CC003         III CONTINUE       CC003         CI TIN=1.*41.*47       C			GC TC 18		000021
V1-0-0.14       00002         VA=0.25*VI       00002         G0 TG 18       00002         V1-0.65       00002         V1-0.65       00002         VA=0.25*VI       00002         ADE=0.008       00002         ADE=0.008       00002         ADE=0.008       00002         ADE=0.008       00002         AKDI=0.400       00002         AKAD=0.400N       00002         AKAD=0.400N       00002         AKAD=0.400N       00002         AKAD=0.400N       00002         AKAD=0.400N       00002         GC TC 18       00002         C XXXXXX       000033         DC 11 N=1.75       00033         DC 11 N=1.75       00033         DC 11 N=1.75       00033         C XXXXXX       00033         O 11 M=1.80       00033         S(N, M)=0.       000033         11 CONTINUE       000033         C XXXXXX       000033         10 TIC=1TC+1.       000033         10 TIC=1TC+1.       000033         11 CONTINUE       000033         C XXXXXX       000033         GO TC 49       00033<		15	U1=0.14		000029
CA-0.25.4VI       CC002         GD TG 18       00002         GD TG 18       00002         VI=0.65       00002         VA-0.25.4VI       CC002         ADE-C.000       CC002         AFCT-ADC-CCN       CC002         AKADI=0       CC002         GC TC 18       CC002         GC TC 18       CC002         IDC 11 M=1.400       CC002         GC TXXXXX       CC003         GC TYXXXX       CC003         GC TC 49       CC003 <th></th> <th></th> <th>41 = 0.014</th> <th></th> <th>00002</th>			41 = 0.014		00002
GO TG 16         000022           16         U1=0.65         000022           V1=0.65         000022           VA=0.25*VI         000022           ADD=0.000         000022           ADD=0.000         000022           ADD=0.000         000022           ADD=0.000         000022           ADD=0.000         000022           ARD=1400.*CCN         000022           DL=200.         000022           C         XXXXX         000022           GC TC 18         000022           ITC=0         000022           ITC=0         000022           ITC=0         000022           ITC=0         000023           C XXXXXX         000033           DC 11 M=1.*0         000033           S (K+M)=0.         000033           C XXXXX         000033           C UF(KR=1)41,41,41,47         000033			$VA=0.25 \times VT$		000029
16       UI=0.65       00002         VI=0.25       UI       00002         ADC=0.403       00002         ADDI=0.003       00002         AKADI=9C.*CON       00002         AFAP=180.*CCN       00002         AFAP=180.*CCN       00002         AFAP=180.*CCN       00002         AFAP=180.*CCN       00002         C       TF=14400.       00002         GC TC 18       00002         C       XXXXX       00002         IDC=0       00002       00002         ITC=0       00002       00002         IDC=0       00002       00002         IDC=0       00002       00002         IDC=0       00002       00002         IDC=0       00002       00002         IDT=0       00003       00003         C       XXXXX       00003         DO 11 M=1.75       00003       00003         DO 11 N=1.75       00003       00003         ID IDT=17CP+1       00003       00003         ID IDT=17CP+1       00003       00003         ID IDT=17CP+1       00003       00003         ID IDT=11C+1.       00003       000			GC TC 18		00002
VI=0.65       00023         UA=0.25+UI       000023         ADD=0.008       000023         AFDT=ADE+CEN       000023         AKADI=9C.+CON       000023         AFAP=120.+CON       000023         DL=200.       000023         TF=14400.       000023         GC TC 18       000023         C XXXXX       000023         ITC=0       000023         ITC=0       000023         ITC=0       000023         ITC=0       000023         DC 11 N=1.75       000033         DC 11 N=1.75       000033         DC 11 N=1.75       000033         DC 11 N=1.74       000033         C XXXXX       000033         ID ITC=ITC+1.       000033         ITGP=11CP+1       000033         20 IF(KR=1)41.41.41.47       000033         41 IF(KU=2)42.43.44       000033         42 U=114.04.025(ALP+T)       000033         43 V=VI+VAACCS(ALP+T)       000033         44 U=VI+VAACCS(ALP+T)       000033         V=VI+VAACCS(ALP+T+TCAP)       000033         GC TC 49       000033         44 U=VI+VAACCS(ALP+T+TCAP)       000033         GC TC		16	UI=0.65		000029
U=0.25+UI       00002         Y=0.25+VI       00002         ACC=0.000       00002         AFCT=ADC+CON       00002         AFADC=20.+CON       00002         DL=200.       00002         DL=200.       00002         GC TC 18       00002         C XXXXXX       00002         ITC=0       00002         ITC=0       00002         C XXXXXX       00003         D0 11 N=1.75       00003         D0 11 N=1.75       00003         C XXXXXX       00003         C XXXXXX       00003         C XXXXXX       00003         C XXXXXX       00003         C XXXXX       00003         C UITUHUA       00003<			VI=0.65		000029
VA=0.25×VI       00002         ADC=0.008       00002         AFCT=ADC+CON       00002         AFADT=9C.*CON       00002         AFAP=180.*CON       00002         DL=200.       00002         GC TC 18       00002         IF=14400.       00002         GC TC 18       00002         ITC=0       00002         ITC=0       00002         ITC=0       00002         ITC=0       00003         DC 11 N=1.75       00003         DC 11 N=1.80       00003         S(N,H)=0.       00003         II CONTINUE       00003         C XXXXXX       00003         ID ITC=ITC+1.       00003         ID ITC=ITC+1.       00003         II DP=TICP+1       00003         20 IF(KR=1)41.41.47       00003         GC TC 49       00033         GC TC 49       00033         GC TO 49       00033         GC TO 49       00033         V=VI+VA+CCS(ALP*T)       00033         GC TO 49       00033         V=VI+VA+CCS(ALP*T)       00033         GC TO 49       00033         V=VI+VA+CCS(ALP*T) <t< th=""><th></th><th></th><th>UA=0.25 * UI</th><th></th><th>000029</th></t<>			UA=0.25 * UI		000029
ADC=0.008 AFOT=ADC+CCN CC0022 AKADI=9C+CCN CC0022 OL=200- FF=14400- GC TC 18 T=0- ITC=0 CXXXXX CCXXXXX CC0022 ITCP=0 CXXXXXX CC0022 ITCP=0 CXXXXXX CC0022 CCXXXXXX CC0022 CCXXXXXX CC0023 CCXXXXXX CC0023 CCXXXXXX CC0023 CCXXXXXX CC0023 CCXXXXXX CC0023 CCXXXXXX CC0023 CCXXXXXX CC0023 CCXXXXXX CC0023 CCXXXXXX CC0023 CCXXXXXX CC0023 CCXXXXXX CC0023 CCXXXXXX CC0023 CCXXXXXX CC0023 CCXXXXXX CC0023 CCXXXXXX CC0023 CCXXXXX CC0023 CCXXXXX CC0023 CCXXXXX CC0023 CCXXXXX CC0023 CCXXXXX CC0023 CCXXXXX CC0023 CCXXXXX CC0023 CCXXXXX CC0023 CCXXXXXX CC0033 CCXXXXX CC0033 CCXXXXXX CC0033 CCXXXXXX CC0033 CCXXXXXX CC0033 CCXXXXXX CC0033 CCXXXXXX CC0033 CCXXXXXX CC0033 CCXXXXXX CC0033 CCXXXXXX CC0033 CCXXXXXX CC0033 CCXXXXXX CC0033 CCXXXXX CC0033 CCXXXXXX CC0033 CCXXXXXX CC0033 CCXXXXX CC0033 CCXXXXX CC0033 CCXXXXX CC0033 CCXXXXX CC0033 CXXXXX CC0033 CXXXXX CC0033 CCXXXXX CC0033 CCXXXXX CC0033 CXXXXX CC0033 CXXXXX CC0033 CXXXXX CC0033 CXXXXX CC0033 CXXXXX CC0033 CXXXXX CC0033 CXXXXX CC0033 CXXXXX CC0033 CXXXXX CC0033 CXXXXX CC0033 CXXXXX CC0033 CXXXXX CC0033 CXXXXX CC0033 CXXXXX CC0033 CXXXXX CC0033 CXXXXX CC0033 CXXXXX CC0033 CXXXXXX CC0033 CXXXXXX CC0033 CXXXXXX CC0033 CXXXXXX CC0033 CXXXXXX CC0033 CXXXXX CC0033 CXXXXX CC0033 CXXXXX CC0033 CXXXXXXX CC0033 CXXXXXX CC0033 CXXXXXX CC0033 CXXXXXX CC0033 CXXXXXX CC0033 CXXXXXX CC0033 CXXXXXX CC0033 CXXXXXXX CC0033 CXXXXXX CC0033 CXXXXXXX CC0033 CXXXXXXX			VA=0.25 * VI		000029
AKCT=ADC*CLN       CC0022         AKADI=9C.*CCN       0C0022         DL=200.       CC0022         JL=200.       CC0022         GC TC 18       CC0022         C XXXXX       CC0022         ITC=0       CC0022         ITCP=0       CC0023         C XXXXX       CC0023         DC 11 N=1*75       C00033         DC 11 N=1*75       C00033         DC 11 N=1*75       C00033         SCN.MJ=0.       CC033         C XXXXX       CC033         G TC 4.9       C0033         41 FCKU=2042.43.44       C00033         42 U=U1+UA*CCS(ALP*T)       CC033         G TC 4.9       CC033         G TC 4.9       CC033         G TC 4.9       CC033         G TC 4.9       CC033         G TO 4.9       CC033			ADC = C - C O B		000025
AADJ=9C=4CUN 00002 AFAFP=180.=CCN 00002 GC TC 18 T=14400. GC TC 18 C XXXXX 000022 ITC=0 ITC=0 C XXXXXX 000022 ITC=0 C XXXXXX 000022 ITC=0 C XXXXXX 000033 DC 11 N=1+75 C C00022 C XXXXX 000033 C C XXXXX 000033 C XXXXXX 000033 C XXXXX 000033 C XXXXXX 000033 C XXXXXXX 000033 C XXXXXX 000033 C XXXXXXX 000033 C XXXXXXX 000033 C XXXXXXX 000033 C XXXXXXXXXXX 000033 C XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX			AFCT=ADC*CGN		CC0029
APARP=120.*CUN       00023         DI=200.       00023         IF=14400.       000023         GC TC 18       000023         IIC=0       000023         IIC=0       000023         DC 11 N=1,75       000033         DC 11 N=1,75       000033         DC 11 N=1,75       000033         S(K,M)=0.       000033         S(K,M)=0.       000033         IIC=ITC+1.       000033         IITC=1C+1.       000033         IITC=1C+1.       000033         IITC=S(ALP*T)       000033         V=VI+CDS(ALP*T)       000033         V=VI+VA+CCS(ALP*T)       000033         U=UI+UA+CCS(ALP*T)       000033         U=UI+VA+CCS(ALP*T)       000033					000024
D1-2004       C       C         TF=14400.       00002         GC TC 18       00002         GC TC 18       00002         ITC=0       00002         ITC=0       00002         ITC=0       00002         OC 11 N=1,75       00003         DC 11 N=1,75       00003         DC 11 N=1,75       00003         C XXXXXX       00003         IC CNTINUE       00003         C XXXXXX       00003         IO ITC=ITC+1.       00003         IO ITC=ITC+1.       00003         II IF(KU-2)42,43,44       00003         41 IF(KU-2)42,43,44       00003         V=VI+VA+CCS(ALP+T)       00003         V=VI+VA+CCS(ALP+T)       00003         GO TC 49       00003         43 V=VI+VA+CCS(ALP+T)       00003         U=UI+UA+CCS(ALP+T)       00003         GC TO 49       00003         44 U=UI+UA+CCS(ALP+T)       00003         V=VI+VA+CCS(ALP+T)       00003         V=VI+VA+CCS(ALP+T)       00003         GC TO 49       00003         47 U=UI+UA+CCS(ALP+T)       00003         V=VI+VA+CCS(ALP+T)       00003         V=VI+VA+CC			AFARF=180. CON		000029
GC TC 18       000025         GC XXXXXX       000025         18 T=0.       000025         TTC=0       000025         TC=0       000025         TC=0       000025         C XXXXX       000033         DC 11 N=1,75       000033         DC 11 N=1,75       000033         S(N,M)=0.       000033         11 CONTINUE       000033         C XXXXX       000033         11 TC=1TC+1.       000033         11 TGP=TTCP+1       000033         20 IF(KR=1)41,41,41,47       000033         20 IF(KR=1)41,41,41,47       000033         20 IF(KR=1)41,41,47       000033         20 IF(KR=2)42,43,44       000033         42 U=U1+UA+CCS(ALP+T)       000033         GC TC 49       000033         GU TC 49       000033         GU TC 49       000033         GU TC 49       000033         GU TU+VA+CCS(ALP+T)       000033         U=U1+UA+CCS(ALP+T)       000033         GU TU 49       000033         42 U=U1+UA+CCS(ALP+T)       000033         GC TO 49       000033         47 U=U1+UA+CCS(ALP+T)       000033         V=V1+VA+CCS(			IF = 14400		0.002
C XXXXX 00002 18 T=0. 00002 ITCP=0 000002 C XXXXXX 000003 DC 11 N=1,75 00003 DC 11 N=1,75 00003 C XXXXX 00003 11 CONTINUE 00003 C XXXXXX 00003 10 ITC=ITC+1. 00003 10 ITC=ITC+1. 00003 20 IF(KR-1)41,41,47 00003 41 IF(KU-2)42,43,44 00003 42 U=U1+UA+CCS(ALP+T) 00003 GD TC 49 00003 43 V=V1+VA+CCS(ALP+T) 00003 GD TC 49 00003 43 V=V1+VA+CCS(ALP+T) 00003 GC TC 49 00003 44 U=U1+UA+CCS(ALP+T) 00003 GC TC 49 00003 43 V=V1+VA+CCS(ALP+T) 00003 GC TC 49 00003 43 V=V1+VA+CCS(ALP+T) 00003 GC TC 49 00003 44 U=U1+UA+CCS(ALP+T) 00003 GC TC 49 00003 45 V=V1+VA+CCS(ALP+T) 00003 GC TC 49 00003 46 U=U1+UA+CCS(ALP+T) 00003 GC TC 49 00003 47 U=U1+COS(ARDT+T+APARP) 00003 49 CCNTINUE 00003 C XXXXXX 00003 C XXXXXXX 00003 C XXXXXXX 000003 C XXXXXXX 000003 C XXXXXXX 000003			GC TC 18		000029
18       T=0.       0C0022         ITC=0       0C0022         C       XXXXXX       CC0023         DC       11       N=1,75       000033         DO       11       M=1,75       000033         S(N,M)=0.       000033       000033         11       CONTINUE       000033         12       CXXXXX       000033         13       TC=ITC+1.       000033         14       IF(KR-1)41,41,47       000033         20       IF(KR-1)41,441,47       000033         41       IF(KR-2)42,43,44       000033         42       U=UI+UA * CCS(ALP * T)       000033         y=VI * 40.5C(ALP * T) + TCAF)       000033         0       TC 49       000033         43       V=VI * VA * CCS(ALP * T)       000033         y=VI * VA * CCS(ALP * T)       000033         y=U = U * UA * CCS(ALP * T)       000033         y=VI * VA * CCS(ALP * T)       000033         y=VI * VI * VA * CCS(ALP * T)       000033 <td>3</td> <td></td> <td>XXXXXX</td> <td></td> <td>000029</td>	3		XXXXXX		000029
IIC=0       000023         IICP=0       C00023         C XXXXXX       C00033         DC 11 N=1,75       000033         DC 11 M=1,80       000033         S(N,M)=0.       000033         11 CONTINUE       000033         C XXXXX       000033         10 ITC=ITC+1.       000033         10 ITC=ITC+1.       000033         10 ITC=ITC+1.       000033         11 IP=1TCP+1       000033         20 IF(KR-1)41,41,47       000033         41 IF(KU-2)42,43,44       000033         v=VI+CDS(ALP*T)       000033         v=VI+CDS(ALP*T)       000033         v=VI+CDS(ALP*T)       000033         v=VI+VA+CCS(ALP*T)       000033         v=vI+CCS(ALP*T)       000033         v=vI+CCS(ALP*T)       000033         v=vI+CCS(ALP*T)       000033         v=vI+CCS(ALP*T)       000033         v=vI+CCS(ALP*T) <t< td=""><td></td><td>18</td><td>T=0.</td><td></td><td>000025</td></t<>		18	T=0.		000025
IICP=0       C 0002:         C XXXXX       C0003:         DC 11 N=1,75       00003:         DC 11 M=1,80       00003:         SCN,M)=0.       00003:         11 CONTINUE       00003:         C XXXXX       00003:         10 IIC=ITC+1.       00003:         10 IIC=ITC+1.       00003:         20 IF(KR=1)41,41,47       00003:         41 IF(KU=2)42,43,44       00003:         42 U=UI+UA+CCS(ALP+T)       00003:         V=VI+COS(JLP+T)       00003:         GO TC 49       00003:         43 V=VI+VA+CCS(ALP+T)       00003:         GO TC 49       00003:         44 U=UI+UA+CCS(ALP+T)       00003:         GC TD 49       00003:         44 U=UI+UA+CCS(ALP+T)       00003:         9 CC TO 49       00003:         44 U=UI+UA+CCS(ALP+T)       00003:         9 CC TO 49       00003:         47 U=UI+COS(ARDI+T+AKADI)       00003:         V=VI+COS(ARDI+T+AKADI)       00003:         V=VI+COS(ARDI+T+APARP)       00003:         49 CCNTINUE       00003:         C UNITS CF PHERCMON ADDEC EACH TIME STEP (S0=10.)       00003:         25 S(10,15)=S(10,15)+SC*(1./((AE+T)+1.)) <t< td=""><td></td><td></td><td>ITC=0</td><td></td><td>000029</td></t<>			ITC=0		000029
C XXXXXX CCCCCCCCCCCCCCCCCCCCCCCCCCCCC			IICP=0		CC0029
DC 11 N=1,/5       000031         DC 11 M=1,80       000031         S(N,M)=0.       000031         11 CONTINUE       000031         C XXXXXX       000031         10 ITC=ITC+1.       000031         11 TDP=ITCP+1       000031         20 IF(KR=1)41,41,47       000031         41 IF(KU=2)42,43,44       000031         42 U=UI+UA*CCS(ALP*T)       000031         V=VI*COS(ALP*T)       000031         GO TC 49       000031         43 V=VI+VA*CCS(ALP*T)       000031         GC TO 49       000031         U=UI+UA*CCS(ALP*T)       000031         U=UI+UA*CCS(ALP*T)       000031         U=UI+UA*CCS(ALP*T)       000031         U=UI+UA*CCS(ALP*T)       000031         U=UI+UA*CCS(ALP*T)       000033         V=VI+VA*CCS(ALP*T)       000033         V=VI+COS(AROT*T+AKADI)       000033	C		XXXXXX		CC0C3(
DD 11 M=1,80       000031         S(N,M)=0.       000031         11 CONTINUE       000031         C XXXXX       000031         10 ITC=ITC+1.       000031         11 DP=ITGP+1       000031         20 IF(KR=1)41,41,47       000033         41 IF(KU=2)42,43,44       000033         42 U=U1+UA*CCS(ALP*T)       000033         v=VI+COS(ALP*T+TCAF)       000033         GO TC 49       000033         43 V=VI+VA*CCS(ALP*T)       000033         L=U1+UA*CCS(ALP*T)       000033         GC TO 49       000033         44 U=U1+UA*CCS(ALP*T)       000033         V=VI+VA*CCS(ALP*T)       000033         V=VI+VA*CCS(ARDT*T+APARP)					000030
11       CONTINUE       000031         C       XXXXXX       000031         10       ITC=ITC+1.       000031         11       CCCC3       000031         20       IF(KR-1)41.41.47       000031         41       IF(KU-2)42.43.44       000031         42       U=UI+UA*CCS(ALP*T)       000031         V=VI*COS(ALP*T+TCAF)       0000331         GO TC 49       0000331         43       V=VI+VA*CCS(ALP*T)       0000331         GC TC 49       0000331         GC TO 49       0000332         GC TO 49       0000333         GC TO 49       0000333      <					000030
C       XXXXXX       00003(         10       ITC=ITC+1.       00003(         110       ITC=ITC+1.       00003(         20       IF(KR-1)41,41,47       00003(         41       IF(KU-2)42,43,44       00003(         42       U=UI+UA*CCS(ALP*T)       00003(         v=VI*COS(ALP*T+TCAF)       00003(         GO TC 49       00003(         43       V=VI+VA*CCS(ALP*T)       00003(         GC TC 49       00003(         GC TC 49       00003(         GC TO 49       00003(         GC TO 49       00003(         GC TC UNITS CF PHERCMON ADDEC EACH TIME STEP (S0=10.)       00003(         C 10 UNITS CF PHERCMON ADDEC EACH TIME STEP (S0=10.)       00003(		11	CONTINUE		000030
10       ITC=ITC+1.       00003( 00003( 00003( 41       IF(KR-1)41,41,47       00003( 00003( 42       00003( 00003( 42       00003( 00003( 00003( 42       00003( 00003( 00003( 00003( 43       00003( 00003( 00003( 00003( 43       00003( 00003( 00003( 00003( 44       00003( 00003( 00003( 00003( 00003( 00003( 44       00003( 00003( 00003( 00003( 00003( 00003( 00003( 44       00003( 00003( 00003( 00003( 00003( 44       00003( 00003( 00003( 00003( 00003( 44       00003( 00003( 00003( 00003( 45       00003( 00003( 00003( 00003( 47       00003( 00003( 00003( 00003( 47       00003( 00003( 00003( 47       00003( 00003( 00003( 47       00003( 00003( 49       00003( 10       000	C	**	XXXXXX		000030
ITOP=ITOP+1       CCCC32         20       IF(KR-1)41,41,47       000030         41       IF(KU-2)42,43,44       000030         42       U=UI+UA*CCS(ALP*T)       000030         w=VI*COS(ALP*T+TCAF)       CCC030         GO TC 49       000030         43       V=VI+VA*CCS(ALP*T)       000030         u=UI*COS(ALP*T+TCAF)       000030         GG TO 49       000030         44       U=UI+UA*CCS(ALP*T)       000030         v=VI+VA*CCS(ALP*T)       000030         v=VI+VA*CCS(ALP*T)       000030         v=VI+VA*CCS(ALP*T)       000030         v=VI+VA*CCS(ALP*T)       000030         v=VI+VA*CCS(ALP*T)       000030         v=VI+VA*CCS(ALP*T+TCAP)       000030         GC TO 49       000030         47       U=UI+UA*CCS(ALP*T)       000030         v=VI+COS(AROT*T+AKADI)       000031         v=VI*COS(AROT*T+APARP)       000031         49       CCNTINUE       000031         C       10       UNITS CF PHERCMON ADDEC EACH TIME STEP (SD=10.)       000031         25       S(10,15)=S(10,15)+SC*(1./((AE*T)+1.))       000331         C       XXXXXX       0000331         C <td< td=""><td></td><td>10</td><td>ITC=ITC+1.</td><td></td><td>000030</td></td<>		10	ITC=ITC+1.		000030
20       IF(KR-1)41,41,47       000030         41       IF(KU-2)42,43,44       000030         42       U=UI+UA*CCS(ALP*T)       000030         v=VI*COS(ALP*T+TCAF)       000030         GO TC 49       000030         43       V=VI+VA*CCS(ALP*T)       000030         GO TC 49       000030         44       U=UI+UA*CCS(ALP*T)       000030         GC TO 49       000030         44       U=UI+UA*CCS(ALP*T)       000030         GC TO 49       000030         44       U=UI+UA*CCS(ALP*T)       000030         GC TO 49       000030         45       V=VI*VA*CCS(ALP*T)       000030         9       V=VI*VA*CCS(ALP*T+TCAP)       000030         9       C00030       000030         9       V=VI*VA*CCS(ALP*T)       000030         9       C00030       000030         9       C00030       000030         9       CCNTINUE       000030         25       S(10,15)=S(10,15)+SC*(1./((AE*T)+1.))       000031         25       S(10,15)=S(10,15)+SC*(1./((AE*T)+1.))       000031         26       TO 251       000031         26       TO 251       000031		-	ITOP=ITOP+1		000030
41       IF(KU-2)42+43+44       000036         42       U=UI+UA*CCS(ALP*T)       000036         V=VI*COS(ALP*T+TCAF)       000036         GO TC 49       000036         43       V=VI+VA*CCS(ALP*T)       000036         GC TC 49       000036         GC TO 49       000037         GC TO 49       000036         Y=VI*COS(ARDT*T+AKADI)       000037         V=VI*COS(ARDT*T+AKADI)       000037         V=VI*COS(ARDT*T+APARF)       000037         C       10       UNITS CF PHERCMON ADDEC EACH TIME STEP (S0=10.)       000037         C       XXXXXX       00037         GC TO 251       000037		20	IF(KR-1)41,41,47		000030
42       U=UI+UA*CCS(ALP*T)       00003(         V=VI*COS(ALP*T+TCAF)       00003(         GD       TC       49         43       V=VI+VA*CCS(ALP*T)       00003(         L=UI*COS(ALP*T+TCAF)       00003(         GC       TO       49         44       U=UI+UA*CCS(ALP*T)       00003(         V=VI+VA*CCS(ALP*T)       00003(         GC       TO       49         6C       TO       49         7       U=UI*COS(ARDT*T+AKADI)       00003(         7       U=UI*COS(ARDT*T+APARF)       00003(         49       CCNTINUE       00003(         C       10       UNITS CF       PHERCMON         25       S(10, 15) = S(10, 15) + SC*(1./((AE*T)+1.))       00003(         C       XXXXXX       00003(       00003(         C       XXXXXX       CCC03(		41	IF(KU-2)42,43,44		000030
V=VI*CDS(ALP*T+TCAP)       CCC03(         GD TC 49       00003(         43 V=VI+VA*CCS(ALP*T)       00003(         L=UI*CDS(ALP*T+TCAP)       00003(         GC TO 49       00003(         44 U=UI+UA*CCS(ALP*T)       00003(         V=VI+VA*CCS(ALP*T)       00003(         0C TO 49       00003(         45 U=UI*CDS(ALP*T)       00003(         0C TO 49       00003(         46 U=UI+UA*CCS(ALP*T)       00003(         0C TO 49       00003(         47 U=UI*CDS(ARDT*T+AKADI)       00003(         V=VI*CDS(ARDT*T+APARF)       00003(         49 CCNTINUE       00003(         C       10 UNITS CF PHERCMON ADDEC EACH TIME STEP (S0=10.)       00003(         25 S(10,15)=S(10,15)+SC*(1./((AE*T)+1.))       00003(         C       XXXXXX       00003(         C       XXXXXX       00003(		42	U=UI+UA *CCS(ALP *T)		000030
GU IC 49       000030         43 V=VI+VA*CCS(ALP*T)       000030         L=UI*COS(ALP*T+TCAF)       000030         GC TO 49       000030         44 U=UI+UA*CCS(ALP*T)       000030         V=VI+VA*CCS(ALP*T)       000030         GC TO 49       000030         47 U=UI*COS(AROT*T+AKADI)       000030         V=VI*COS(AROT*T+AKADI)       000030         V=VI*COS(AROT*T+AFARF)       000030         49 CCNTINUE       000030         C       10 UNITS CF PHERCMON ADDEC EACH TIME STEP (S0=10.)       000030         25 S(10,15)=S(10,15)+SC*(1./((AE*T)+1.))       000030         C       XXXXXX       000031         C       XXXXXX       000031			V=VI*CUSCALP*T+TCAF)		CCC03(
43       V=VI+VA*CCS(ALP*T)       00003(         G0       T0       49       00003(         44       U=UI+UA*CCS(ALP*T)       00003(         V=VI+VA*CCS(ALP*T)       00003(         V=VI+VA*CCS(ALP*T+TCAP)       00003(         G0       T0       49         47       U=UI*COS(ARDT*T+AKADI)       00003(         V=VI*COS(ARDT*T+AKADI)       00003(         C       10       15)+SC*(1./((AE*T)+1.))       00003(         C       XXXXXX       00003(       00003(         C       XXXXXX       00003(       00003(		1.7			000030
GC TO 49       C00030         44 U=UI+UA*CCS(ALP*T)       000030         V=VI+VA*CCS(ALP*T+TCAP)       000030         GC TO 49       000030         47 U=UI*COS(AROT*T+AKADI)       000030         V=VI*COS(AROT*T+AKADI)       000030         V=VI*COS(AROT*T+APARP)       000030         49 CCNTINUE       000030         C 10 UNITS CF PHERCMON ADDEC EACH TIME STEP (S0=10.)       000030         25 S(10,15)=S(10,15)+SC*(1./((AE*T)+1.))       000030         C XXXXXX       000032         C XXXXXX       000032		4.3			000031
44       U=UI+UA*CCS(ALP*T)       00003(         V=VI+VA*CCS(ALP*T+TCAP)       00003(         GC       TC       49         47       U=UI*COS(AROT*T+AKADI)       00003(         V=VI*COS(AROT*T+AFARF)       00003(         49       CCNTINUE       00003(         C       10       UNITS CF PHERCMON ADDEC EACH TIME STEP (SO=10.)       00003(         25       S(10,15)=S(10,15)+SC*(1./((AE*T)+1.))       00003(         C       XXXXXX       00003(         C       XXXXXX       00003(					000030
V=VI+VA*CCS(ALP*I+TCAP)       000030         GC TO 49       000030         47 U=UI*COS(AROT*I+AKADI)       000030         V=VI*COS(AROT*I+APARF)       000030         49 CCNTINUE       000030         C 10 UNITS CF PHERCMON ADDEC EACH TIME STEP (SO=10.)       000032         25 S(10,15)=S(10,15)+SC*(1./((AE*T)+1.))       000032         C XXXXXX       000032		44	U=UI+UA * CCS(ALP*T)		000030
GC TC 49       C00030         47 U=UI*COS(AROT*I+AKADI)       000030         V=VI*COS(AROT*I+APARF)       000030         49 CCNTINUE       CC0030         C 10 UNITS CF PHERCMON ADDEC EACH TIME STEP (S0=10.)       000032         25 S(10,15)=S(10,15)+SC*(1./((AE*T)+1.))       000032         C XXXXXX       000032         C XXXXXX       CC0332			V=VI+VA*CCS(ALP*I+TCAP)		000030
47       U=UI*CDS(ARDT*T+AKADI)       000030         V=VI*CDS(ARDT*T+APARF)       000030         49       CCNTINUE       000030         C       10       UNITS CF PHERCMON ADDEC EACH TIME STEP (S0=10.)       000030         25       S(10,15)=S(10,15)+SC*(1./((AE*T)+1.))       000030         C       XXXXXX       000030         C       XXXXXX       000030			GC TC 49		000030
V=VI*COS(ARDI*T+APARF)       000030         49       CCNTINUE       000030         C       10       UNITS CF PHERCMON ADDEC EACH TIME STEP (SO=10.)       000030         25       S(10,15)=S(10,15)+SC*(1./((AE*T)+1.))       000030         C       XXXXXX       000030         C       XXXXXX       000030		47	U=UI*COSCAROT*T+AKADI)		000030
49 CCNTINUE       'CC0030         C       10 UNITS CF PHERCMON ADDEC EACH TIME STEP (S0=10.)       000032         25 S(10,15)=S(10,15)+SC*(1./((AE*T)+1.))       000032         C       XXXXXX       000032         C       XXXXXX       000032         C       XXXXXX       CC0332			V=VI*COS(AROT*T+APARF)		000031
C       IG UNITS OF PHENUMUN ADDEC EACH TIME STEP (SO=10.)       000033         25       S(10,15)=S(10,15)+SC*(1./((AE*T)+1.))       000033         C       XXXXXX       000033         C       XXXXXX       000033         C       XXXXXX       CCC033	~	49	CENTINUE		CC003(
C XXXXXX CCCC032	ι	25	IU UNITS OF PHEROMON ADDEC EAT	CH TIME STEP (SO=10.)	00003:
GC TC 251 000032 C XXXXXX CCC032	C	20	3(10)13)=2(10)13)+2(*(1./((AE)	«[]+1•])	000032
C XXXXXX CCCC3	·		GC TC 251		000037
	С		XXXXXX		CCC03:

252	IF(KL-1)27,27,26	000032
26	S(14,15)=S(14,15)+S0*(1./((AE+T)+1.))	00003
	S(18,15)=S(18,15)+SO*(1./((AE*T)+1.))	00003;
	\$(22,15)=\$(22,15)+\$0*(1./((AE*T)+1.))	00003;
	S(26,15)=S(26,15)+SC*(1./((AE*T)+1.))	00003;
	S(30, 15) = S(30, 15) + S0 + (1./((AE + T) + 1.))	00003;
	GC TC 27	00003:
251	S(12, 15) = S(12, 15) + SE + (1, / ((AE + T) + 1, ))	00003:
	S(14,15) = S(14,15) + SC + (1, /((AF+T)+1, 1))	000031
	S(16,15) = S(16,15) + S(1,1) + (1,1) + (1,1) + (1,1)	00003
	$S(18,15) = S(18,15) + S\Gamma + (1, /((AF + T) + 1, 1))$	00003
	S(20, 15) = S(20, 15) + S0 + (1 - /((AF + T) + 1 - ))	00003
	S(22 + 15) = S(22 + 15) + S(1 + (1 - /(( AF + T) + 1 - )))	00003
	$S(24 \cdot 15) = S(24 \cdot 15) + S(1 \cdot 1) + S(1 \cdot 1) + 1 - 1)$	00003
	S(26.15) = S(26.15) + S(1.11) + (1.11	00003
	$S(28_15) = S(28_15) + S(1+1) / ((A_{2+1}) + 1)$	00003
	S(30, 15) = S(30, 15) + S0 + (1 / / / / S + T) + 1 )	00003
27		00003
<b>L</b> 1	STA=0	00003
70		00003
20		00003
		00003
	SUA=SUA+S(N)MJ	00003
		00003
21	SH=(S(N,M)-S(N,M-1))/DL	00003
117-101	GU TC 33	00004
32	SH=(S(N,M)-S(N,M+1))/DL	00004
33	IF (V)34,3E,36	C C O O 4
34	SV=(S(N,M)-S(N-1,M))/DL	00004
-3 A	GO TO 35	00004
36	SV = (S(N,M) - S(N+1,M))/OL	00004
35	S(N+H)=S(N+H)=(TD*ABS(U)*SH)=(TD*ABS(V)*SV)	00004
	SUS=SUS+S(N,M)	00004
50	CCNTINUE	00004
	IF(IIC-IAC)80,55,80	00004
55	CALL SILITA(S,ALPH)	CCCOS
	U1=SUA/SUS	00005
	DC 60 N=1,75	00005
	DC 6C M=1,80	00005
	S(N, H) = S(N, H) + U1	00005
60	CCNTINUE	00005
С	EFFECTS OF INCREASING LAYER THICKNESS APPROXIMATE	00005
2	FACTOR -CTR REFERRES TO METERS FROM SOURCE	0000
	CTR=0.015	0000
	IF(KA-1)81,81,61	00005
61	DO 131 N=1,75	00005
	DO 131 M = 1.80	00005
	PF(N,M) = S(N,M)	00005
131	CCNTINUE	00005
	IF(KR-1)62,62,69	00005
62	IF(KU-2)63,62,69	00001
63	DC 64 N=1,75	CC001
	DC 64 M = 1,80	0000
	DIS = (M - 15) * 0.01 * DL	0000
	IF(DIS)51,51,52	0000
51	RRC=1.	0000
	GO TO 53	0000
52	RRC=(1, -(CTR+DTS))	
52	$PF(N \cdot M) = FF(N \cdot M) + PPC$	
64	CONTINUE	CCOO
~ ~		0000
	an in nT	000

65	D0 66 N=1+75	00005
	DTS = (N = 10) + 0.01 + 0.01	00005
		60005
54		00005
2~	60 TC 57	00005
56	$850 \pm (1. \pm (118 \pm 015))$	00005
57	PE(N = M) = PE(N = M) + BP(	20000
66	CENTINGE	00005
	GD TC 81	00005
67	D0 68 N=1-75	00005
•••	DD 68 M=1+80	CCC05
	IF(M=15)58+58+59	00005
58	RFC=1.	00005
	GC TC 82	00005
59	IF(N-10)58,58,83	00005
83	DIS=SGRT((N-15)**2.*(N-10)**2.)*0.01*DL	00005
	RRC=(1(CIR*DIS))	000055
82	PF(N,M)=PF(N,M)*RRC	000055
68	CENTINUE	000055
	GO TO 81	000055
69	DC 84 N=1,75	000051
	DC 84 M=1,80	000055
	IF(M-15)86,86,87	000055
86	REC=1.	000055
	GO TC 88	000055
67	$DIS=(M-15) \pm 0.01 \pm DL$	000055
	RRC=(1(0.5*CTR*DIS))	000055
83	PF(N,M)=FF(N,M)*RRC	000055
	IF(N-25)85,89,91	000055
63	RRC=1.	000055
	GC TO 94	CCCC51
91	DIS=(N-25)*0.01*DL	000055
	RRC=(1(C.5*CTR*DIS))	000055
94	PF(N,M)=FF(N,M)*RRC	000055
84	CGNTINUE	000055
81	ITC=0.	000055
63	IF(ITCP-IFR)90,85,90	000057
85	IF(KA-1)122,122,121	CC0057
121	CALL PRIFNS(PF+T+U+V+UI+VI+TD+DL+KA)	000057
	GC TO 123	000057
122	CALL PRIFYSCSATAUAVAUTAVIATUAULAKA)	CC05E
123		000055
90		CO0055
71	1F( = FJ10p/1p/1	000059
(1	N 3= N 3+ 1	000055
	TECKE-1070-00	000055
70		000055
77	TC(KE=2)7/2+100+100	000059
71	17 L N L ~ Z J [ 47 ] J 7 [ 0 L T - L T 10 ] L	000055
44	VI=U1:004 VI=U1:004	000060
		000001
	$VA=0.25 \pm VT$	000001
	TECHT-1_050111.110.110	0000001
110	DI = 800	000001
111	GD TC 18	000001
75	VI = -C - 4	000001
	UT=VI*(-TURC)	000001
	$UA=0.25 \pm UT$	000001
		000001

VA=0.25\*VI IF(VI-1.05)113,112,112 112 DL=200. 113 GO TC 18 76 UI=UI+0.3 VI=VI-0.3 UA=0.25\*UI VA=0.25\*VI IF(UI-1.05)115,114,114 114 DL=2CO. 115 GC TO 18 100 STOP

END

CC006: 00006: 00006: 00006: 00006: 00006: 00006: 00006: 00006: 00006:

000063

-44-

	SUBROUTINE SILITA (SFALPHA)	000064
	CIMENSION S(75,80)	200000
	NE=75	000066
	ME=8C	000067
	BET=C1ALPHA)/4.	000068
	DO 123 N=2,74	000069
	DC 123 M=2+79	00070
103	IF(1-N) 105,107,105	000071
105	VAUP=S(N-1,M)	00072
	GD TO 108	C00073
107	VAUP=SCN. N)	000074
108	IF(NE-N)110,112,110	000075
110	VALO=S(N+1,M)	000076
	GO TO 113	000077
112	VALC=S(N.K)	00078
113	IF(1-M) 115, 116, 115	000079
115	VALE = S(N + k - 1)	000080
	GC TC 117	000081
116	VALE=S(N+K)	000082
117	IF(ME-M)119,121,119	C00083
119	VARIES(N.N+1)	000084
/	GC TC 122	000004
121	VARTES(N.K)	000000
122	$S(N_*N) = AI FHA + S(N_*N) + BET + (VAUD + VAI D + VAI C + VAD$	· · · · · · · · · · · · · · · · · · ·
123	CONTINUE	.) 000087
103	CONTINUE Rethon	000088
	C 1 U C N	000009
		CCC09C



