



Cressman

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MPDATA

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Cressman

NOAA

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¹ Cressman

² Bathymetry

³ Salinity, Temperature and Density(S,T,D)

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WAM

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POM

Cressman

¹ Portal
² Wave Model
³ Co-tidal chart
⁴ Tidal stream analysis

$$r_{i,j} = \cos^{-1}[\sin(glat) \times \sin(slat) + \cos(glat) \times \cos(slat) \times \cos(glon - slon)] \times earthradius \quad (1)$$

$$lon \quad lat \quad g \quad s \quad r_{i,j}$$

$$F_g = \frac{\sum_{i=1}^n (W_{i,j} \times F_o)}{\sum_{i=1}^n W_{i,j}} \quad (2)$$

$$W_{i,j} = \max(0, \frac{R^2 - r_{i,j}^2}{R^2 + r_{i,j}^2}) \quad (3)$$

$$W_{i,j} \quad F_o \quad F_g$$

$$r_{i,j} \quad R \quad W_{i,j} \quad R$$

ECMWF

[] WAM

S_2 M_2 •

30° / hour

15° / hour

O_1 K_1 •

S_a S_{sa} M_m M_f P_1 K_1 •

S_2 M_2 •

¹ Influence Radius

² European Center for Medium-range Weather Forecasts

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$O_1 \quad K_1$

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$$ML = M_2 + S_2 + K_1 + O_1 + 0.15 \quad ()$$

Kelvin

$L = 300 \text{ Km} \quad h = 35 \text{ m}$

Kelvin

$\phi = 27^\circ$

$k) \quad kh$

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$(kh \approx 0.9 < 3.0)$

(h)

[] (Hasselmann-1981)

: ()

(y)

$$\frac{\partial^2 \eta}{\partial y \partial t} - f \frac{\partial \eta}{\partial x} = 0 \quad , \quad y = 0, L \quad ()$$

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(Kelvin) η

$$\frac{\partial}{\partial t} \left\{ \left(\frac{\partial^2}{\partial t^2} + f^2 \right) \eta - C_0^2 \nabla^2 \eta \right\} = 0 \quad ()$$

t x

$$\eta = \text{Re } \bar{\eta}(y) e^{i(kx - \sigma t)} \quad ()$$

() ()

y

$\bar{\eta}(y)$

$\bar{\eta}$

$$\frac{d^2 \bar{\eta}}{dy^2} + \alpha^2 \bar{\eta} = 0 \quad , \quad \alpha^2 = \frac{\sigma^2 - f^2}{C_0^2} - k^2 \quad ()$$

$$\frac{d\bar{\eta}}{dy} + f \frac{k}{\sigma} \bar{\eta} = 0 \quad , \quad y = 0, L \quad ()$$

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$$\bar{\eta} = A \sin \alpha y + B \cos \alpha y \quad ()$$

: B A

$$y = L \quad y = 0 \quad ()$$

¹ Admiralty Method of Tidal Prediction NP 159

$$\alpha A + \frac{fk}{\sigma} B = 0 \quad ()$$

$$A \left\{ \alpha \cos \alpha L + \frac{fk}{\sigma} \sin \alpha L \right\} + B \left\{ \frac{fk}{\sigma} \cos \alpha L - \alpha \sin \alpha L \right\} = 0 \quad ()$$

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$$(\sigma^2 - f^2)(\sigma^2 - C_0^2 k^2) \sin \alpha L = 0 \quad ()$$

$$n = 0 \quad \sigma^2 = C_0^2 k^2$$

:

x

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Kelvin

$$\alpha^2 = -\frac{f^2}{C_0^2}, \alpha = \pm \frac{if}{C_0} \quad ()$$

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$$\alpha = \frac{if}{C_0}$$

$$\eta = \eta_0 e^{-fy/C_0} \cos(k[x - C_0 t] + \varphi) \quad ()$$

$$u = \frac{\eta_0}{h} C_0 e^{-fy/C_0} \cos(k[x - C_0 t] + \varphi) = -\frac{g}{f} \frac{\partial \eta}{\partial y} \quad ()$$

$$v = 0 \quad ()$$

y

$$C_0 = \sqrt{g \cdot h}$$

η_0

f Kelvin

η

h

x

ϕ

$$\sigma = C_0 k \quad ()$$

Kelvin

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$O_1 \quad K_1 \quad S_2 \quad M_2$

$$u = \sum_{j=1}^4 u_j, \quad \eta = \sum_{j=1}^4 \eta_j, \quad j = \text{Main Constituents} \quad ()$$

$$\eta_{\text{water surface level}} = \sum_{j=1}^4 [\eta_{0j} e^{\frac{-fy}{C_0}} \cos(kx - \sigma t + \varphi_j)] \quad j, \text{ used for } M_2, S_2, K_1 \text{ \& } O_1 \quad ()$$

$$u_{\text{tidal stream}} = \sum_{j=1}^4 [(\eta_{0j} C_0 / h) e^{\frac{-fy}{C_0}} \cos(kx - \sigma t + \varphi_j)] \quad j, \text{ used for } M_2, S_2, K_1 \text{ \& } O_1 \quad ()$$

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$$\varphi_j \quad \eta_{0j} \quad ()$$

Kelvin

Cresman

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Fay

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Lehr

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¹ Warm up
² Neap
³ Spring

$$A = 2270\Delta^{2/3} \cdot V^{2/3} t^{1/2} + 40\Delta^{1/3} \cdot V^{1/3} U_{wind-10m}^{4/3} t \quad ()$$

$$\rho_o \quad \rho_w \quad \Delta = (\rho_w - \rho_o) / \rho_o \quad V \quad A$$

$$. \quad t \quad U_{wind-10m}$$

$$\vec{U} = k_t \vec{U}_{tide} + k_w (\vec{U}_{wind} + \vec{U}_{wave}) \quad ()$$

$$\vec{U}_{wind-10m} \quad k_w \quad k_t \quad U_{tide} \quad \vec{U}_{wave} \quad \vec{U}_{wind} \quad (\vec{U}_{wind} + \vec{U}_{wave}) \quad k_w$$

$$\vec{U} = k_t \vec{U}_{tide} + k_w \vec{U}_{wind-10m} \quad ()$$

$$k_w \quad k_t \quad k_t$$

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$$S_h = [R]_0^1 \sqrt{12D_h \Delta t} \quad ()$$

$$X = X_0 + U_x \Delta t + S_h \cdot \cos \theta \quad ()$$

$$Y = Y_0 + U_y \Delta t + S_h \cdot \sin \theta \quad ()$$

$$\theta = 2\pi [R]_0^1 \quad ()$$

$$\theta \quad D_h \quad [R]_0^1$$

$$Y_0 \quad X_0 \quad \pi \quad \vec{U}(U_x, U_y) \quad Y \quad X$$

$$y \quad x \quad y \quad x$$

[] Mackay 1980

¹ Tidal factor

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$$F_{ev} = \left(\frac{\alpha_{ev}}{C}\right) \cdot [\ln P_0 + \ln(C \cdot K_E \cdot t + 1/P_0)] \quad ()$$

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$$k_E = 0.0025 U_{wind}^{0.78} A \cdot v / (R \cdot T \cdot V_0) \cdot \alpha_{ev} \quad F_{ev}$$

V_0 T R

() () C T_E P_0

$$\ln P_0 = 10.6(1 - T_0/T_E) \quad ()$$

$$C = 1158.9 A P I^{-1.1435} \quad ()$$

[] Cohen 1980

$$F_{dis} = k_d A S \quad ()$$

S A k_d F_{dis}

...

Rasmussen 1985

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$$F_{em} = \left(1 - e^{-k_A k_B (1 + U_{wind-10m})^2 t}\right) / k_B \quad ()$$

k_B k_A F_{em}

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Admiralty

O_1 K_1 S_2 M_2

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ISME2007

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g s

- : A
- : A
- : API
- : C
- : C_0
- : D_h
- : f
- : F_{dis}
- : F_{em}
- : F_{ev}
- : F_g
- : F_o
- : h
- : K_1
- : k_A
- : k_B
- : k_d
- : k_t
- : k_w
- : lat
- : lon
- : M_2
- : ML
- : O_1
- : P_0
- : R
- : $[R]_0^1$
- : $r_{i,j}$
- : S
- : S_2
- : T

\mathbf{x} : U_x
 y : U_y
: U_{tide}
: U_{wind}
: \mathbf{V}
: V_0
: $W_{i,j}$
: x
: y
: X
: X_0
: Y
: Y_0

: α_{ev}
: ϕ
: φ_j
: η
: $\bar{\eta}(y)$
: η_{0j}
: v
: σ
: θ
: ρ_w
: ρ_0

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NOAA Cressman

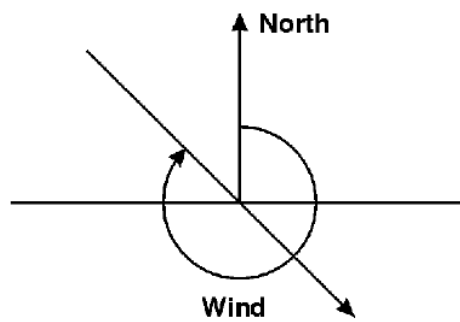
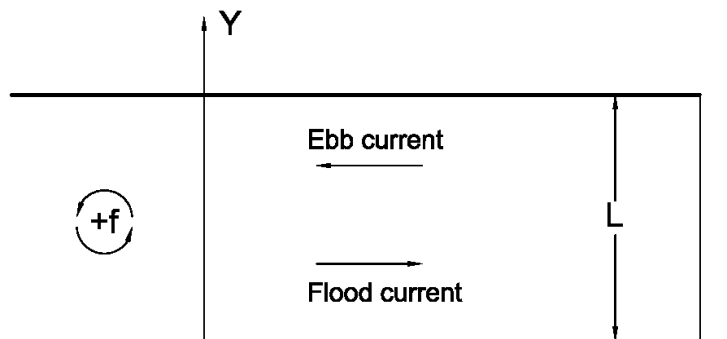
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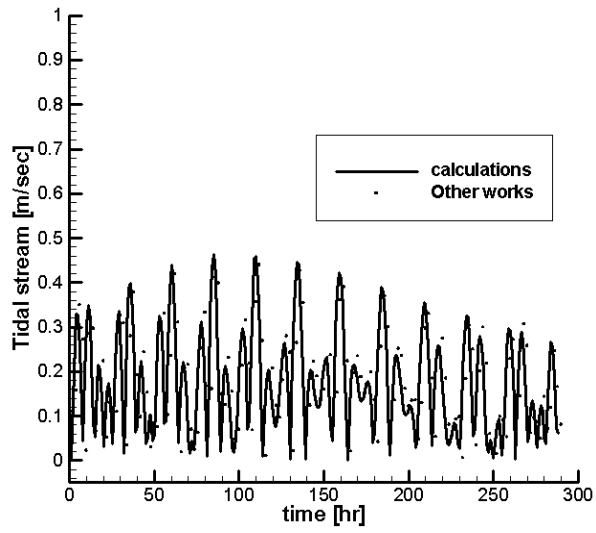
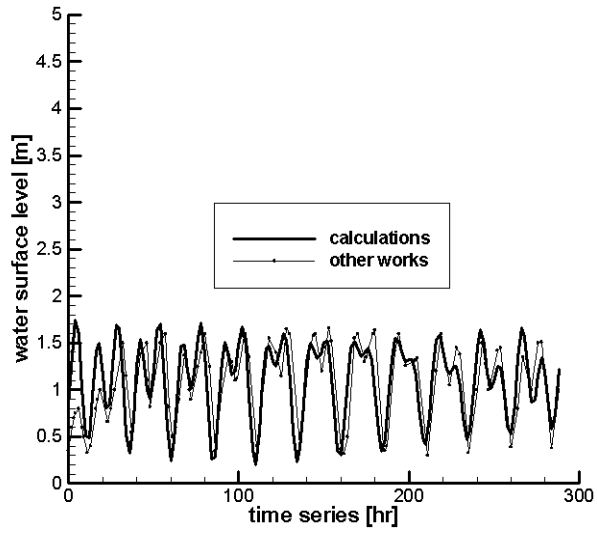
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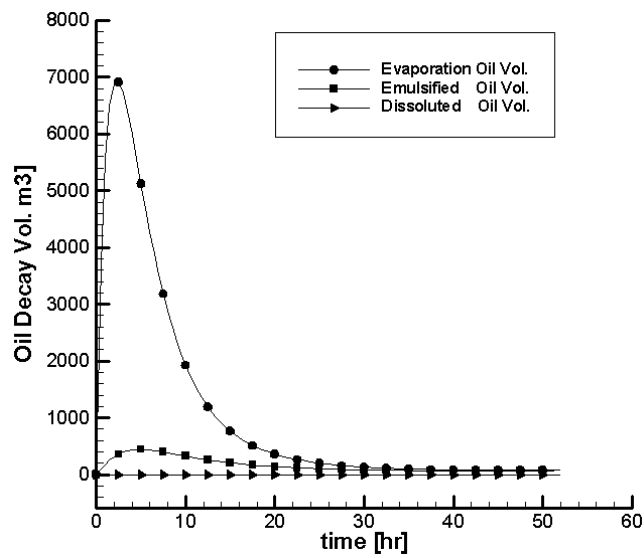
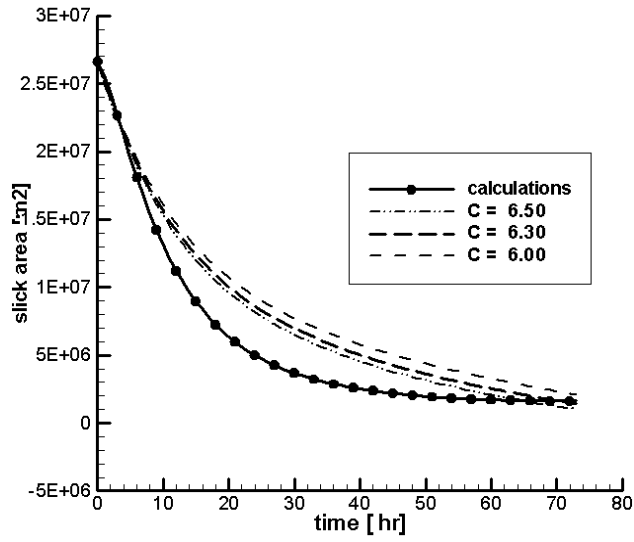
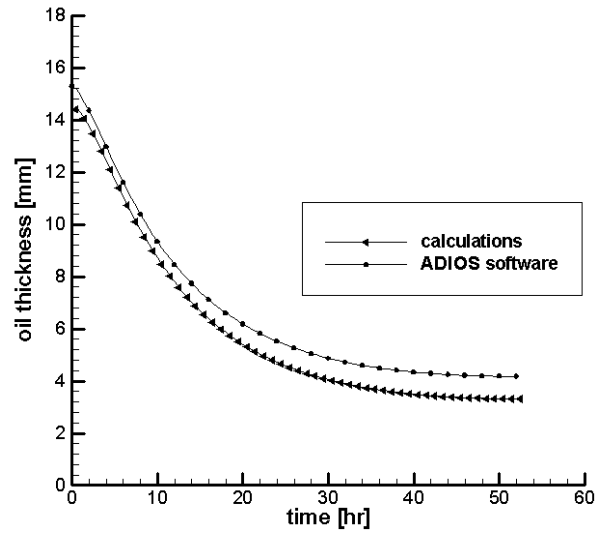
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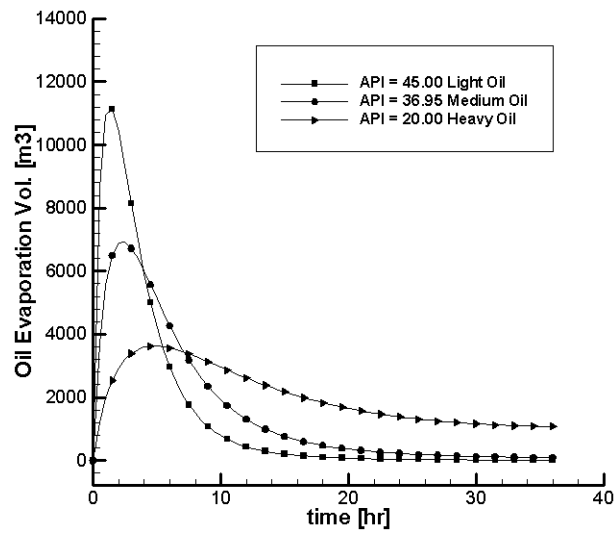
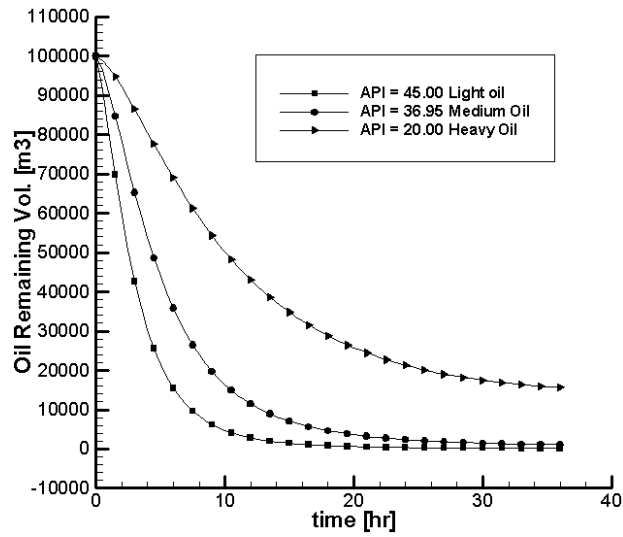
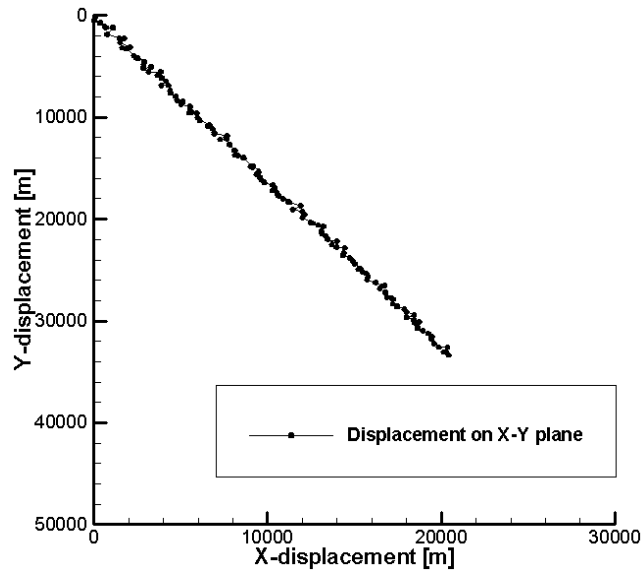
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Abstract

The transport and fate of spilled oil in water bodies are governed by physical, chemical and biological processes that depend on the environmental conditions such as wind, wave, water current, turbulent diffusion, salinity and temperature. Oil spill models usually determine oil movements by vectorial summation of surface current, tidal stream, wind and wave fields and turbulent diffusion. As flow pattern in Persian Gulf is very complicated, it is necessary to obtain water current and tidal stream by measurements or a hydrodynamic model to superimpose wind and wave effects based on an experimental relation.

Here, water current and wind-induced velocities are taken into account to develop a 2-D trajectory model for prediction of oil slick motion. So, a portal including bathymetry, wind field, tidal constituents, oil and water characteristics have been provided for the northern of Persian Gulf waters. Firstly, meteorological data including wind velocity and direction from synoptical stations, have been interpolated by Cressman analysis and an in-house program in whole grids. Then, latitude, longitude, wind velocity, wave height and period, amplitude and phase of constituents and mean water surface level in grids have been determined.

The portal is then, applied to obtain time series of oil surface area and thickness, oil evaporation, oil dissolution and oil emulsification. Sample simulations for oil spill are presented and a comparison of wind and tide data and water surface level for the domain of solution with the observed data and numerical results shows good conformity.