Eros

REFERENCE MANUAL
EROS 2.5 - ENGLISH

WHAT IS Eros MODEL?

The Eros model is a numerical model that solves the continuity equation for the sediment transport in the surf zone, as well as the bed level changes associated with the spatial changes of the sediment transport. The model input is given by the other models such as OLUCA-MC, COPLA-MC, OLUCA-SP and COPLA-SP.

For more details, please refer to the Spanish version of the Mopla and Eros reference manuals.

GENERAL DESCRIPTION

The structure of the process models that constitute a sedimentation/erosion model (Eros) is an essential element in all morphological modelling approaches. The structure of these models is far from trivial and determines the quality of the final result (De Vriend, 1987a).

The figure below shows the architecture of the model Eros within Mopla.

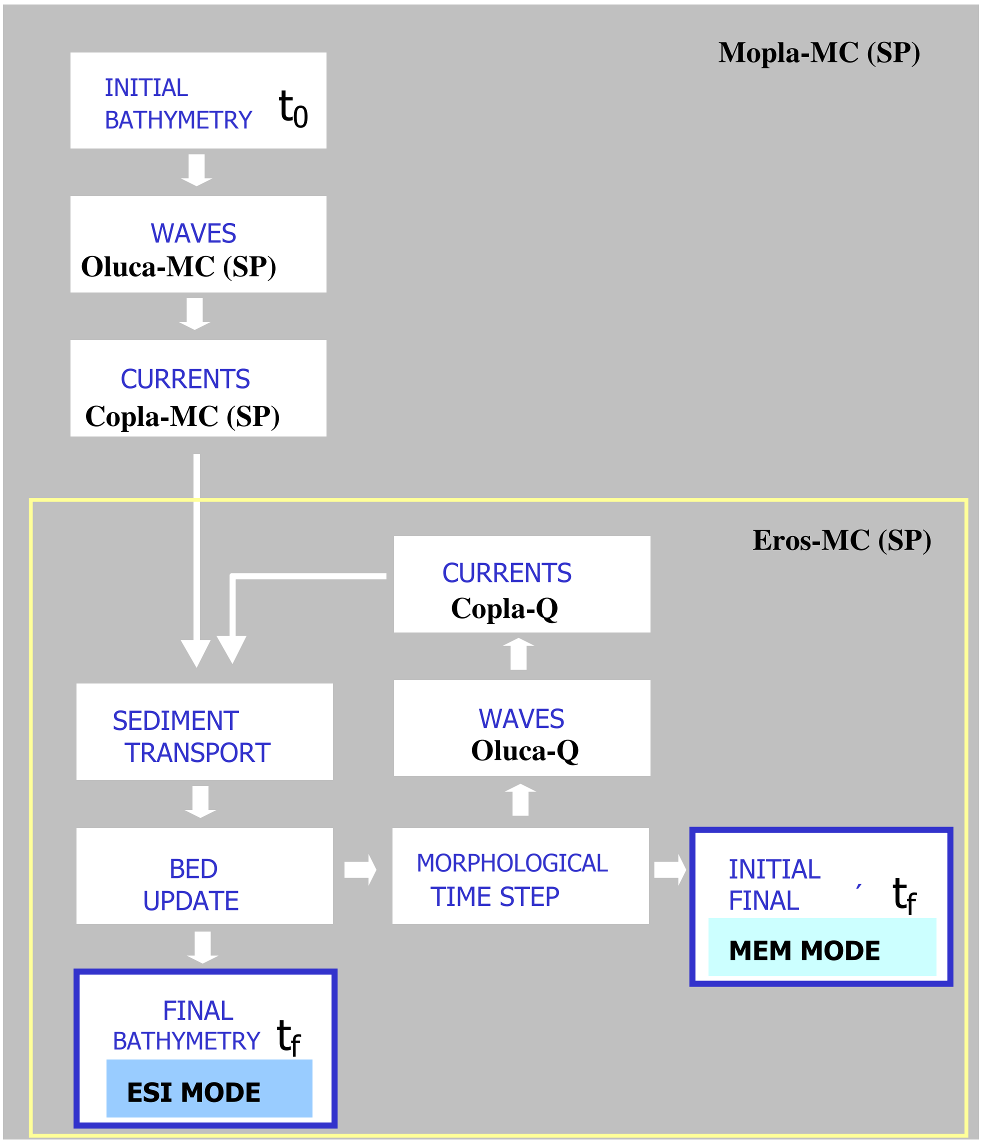

Figure 1.1. Eros architecture

MORPHOLOGICAL EVOLUTION MODEL

1. Sediment transport models

The sediment transport rate can be evaluated by two models. Those are computed from the wave field and current field. The formulations employed are:

(1) Bailard (1981)

(2) Soulsby – van Rijn (1997)

1. Bailard Formulation

The formulation developed by Bailard (1981) reads:

$$\vec{q}_t = \vec{q}_{bo} - \vec{q}_{bs} + \vec{q}_{so} - \vec{q}_{ss}$$

with:

$$\vec{q}_{bo} = \frac{C_f\, \varepsilon_B}{g(s-1)tan\phi} < |\vec{u}|^2 \vec{u} >$$

$$\vec{q}_{bs} = \frac{C_f\, \varepsilon_B tan\beta}{g(s-1)tan^2\phi} < |\vec{u}|^3 > \vec{i}$$

$$\vec{q}_{so} = \frac{C_f \varepsilon_s}{g(s-1)w_s} < |\vec{u}|^3 \vec{u} >$$

$$\vec{q}_{ss} = \frac{C_f\, \varepsilon_s^2 tan\beta}{g(s-1)w_s^2} < |\vec{u}|^5 > \vec{i}$$

where:

g = gravity (m/s^2)
s = $\frac{\rho_s}{\rho_w}$, is relative density
ρ_s = sediment density (ton/m^3)
ρ_w = water density (ton/m^3)
C_f = friction coefficient, with $\vec{\tau} = \rho C_f |\vec{u}|\vec{u}$
$\vec{\tau}$ = bed shear stress (Nw/m^2)
$\vec{u}$ = bed velocity due wave-current interaction (m/s)
ϕ = friction angle (º)

$tan\beta$ = bed slope (-)
$\vec{i}$ = unitary vector in the slope up-direction (-)
w_s = fall velocity of a sediment grain (m/s)
ε_B = bed load efficiency factor (=0.1)
ε_s = suspended load efficiency factor (=0.02)
$<.>$ = temporal average
$|\ |$ = absolute value

each term is:
$\vec{q}_t$ = total sediment transport (bed and suspended) (q_x, q_y)
$\vec{q}_{bo}$ = bed load sediment transport in horizotal plane
$\vec{q}_{bs}$ = bed load sediment transport in inclined plane
$\vec{q}_{so}$ = suspended load sediment transport in horizontal plane
$\vec{q}_{ss}$ = suspended load sediment transport in inclined plane

The bed velocity vector is:

$$\vec{u} = \vec{u}_{orb} + \vec{\bar{u}}$$

where:

$\vec{u}_{orb}$ = bed velocity vector due waves (u_{orbx}, u_{orby})
$\vec{\bar{u}}$ = mean velocity vector integrated in vertical (corriente de rotura), $(\bar{u}, \bar{v})$.

With the x-direction and y-direction notations:

$$\vec{u} = (u_{orb,x} + \bar{u})\vec{i} + (u_{orb,y} + \bar{v})\vec{i}$$

where the orbital velocity is computed from the linear theory:

$$u_{orb} = \frac{\pi H}{T\,\mathrm{senh}(kh)}$$

$u_{orb,x} = u_{orb}\cos\theta$; $u_{orb,y} = u_{orb}\,\mathrm{sen}\,\theta$ where k is the wave number, T is the wave period, h is the depth, H is the wave height, θ is the incident wave angle.

For irregular waves, Soulsby (1997) proposed to use spectral parameters, T_p, *(peak wave period)* and H_{rms} *(root mean square wave height)* instead of T and H. Thus, this model assume that the incident wave angle, θ, is the direction of the mean flow energy, θ_m.

2. Soulsby – van Rijn

Soulsby (1997) developed an analytical expression similar to the formulation with wave-current interaction proposed by van Rijn (1993). This Soulsby approach evaluates load and suspended sediment transport.

$$q_t = A_s \overline{U}\left[\left(\overline{U}^2 + \frac{0.018}{C_D}U_{rms}^2\right)^{\frac{1}{2}} - \overline{U}_{cr}\right]^{2.4}$$

where:

$$q_t = (q_x, q_y)$$

$$A_s = A_{sb} + A_{ss}$$

$$A_{sb} = \frac{0.005h\left(D_{50}/h\right)^{1.2}}{\left[(s-1)g\,D_{50}\right]^{1.2}}$$

$$A_{ss} = \frac{0.012 D_{50} D_*^{-0.6}}{\left[(s-1)gD_{50}\right]^{1.2}}$$

$\overline{U}$ = velocity with vertical averaged $(\overline{u}, \overline{v})$

U_{rms} = root mean square orbital velocity, $U_{rms} = (u_{orb}, v_{orb,y})_{rms}$

$$C_D = \left[\frac{0.40}{\ln\left(h/z_o - 1\right)}\right]^2$$ = friction coefficient due to the current

$\overline{U}_{cr}$ = critical velocity of incipient motion
(effective roughness $K_s = 3D_{90}$, $D_{90} = 2D_{50}$)

$$\overline{U}_{cr} = 0.19(D_{50})^{0.1}\log_{10}\left(\frac{4h}{D_{90}}\right) \qquad 0.1 \le D_{50} \le 0.5mm$$

$$\overline{U}_{cr} = 8.5(D_{50})^{0.6}\log_{10}\left(\frac{4h}{D_{90}}\right) \qquad 0.5 \le D_{50} \le 2mm$$

h = depth
D_{50} = diameter corresponding to 50 percent of the material being finer
D_{90} = diameter corresponding to 90 percent of the material being finer
z_0 = bed roughness ($\cong$ 0.006 m)
s = relative density
g = gravity
ν = kinematics viscosity ($\nu = 2 \cdot 10^{-6}$ m^2/s)

$$D_* = \left[\frac{g(s-1)}{\nu^2}\right]^{1/3} D_{50}$$

2. Sediment conservation model

Continuity equation for sediment transport

Once the sediment transport vector is computed, $\vec{q}_t = (q_x, q_y)$, the continuity equation for the sediment transport is solved:

$$\frac{\partial h}{\partial t} = \frac{1}{1-n}\left(\frac{\partial q_x}{\partial x} + \frac{\partial q_y}{\partial y}\right)$$

where:

h = depth (m)
n = porosity (-)

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