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C#########################################################################
c                                                                        #
c                  SUBROUTINE PROGRAM                                    #
C                VERSION 1.0 (12/07/2009)                                #
C                AUTHORIZED BY ZHANG JINGXIN                             #
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C                           SHANGHAI, CHINA                              #
c------------------------------------------------------------------------#
c          computes the velocity in the vertical direction               #
c                                                                        #
c#########################################################################
      Subroutine WREAL
      Include './Include/OCERM_INF'
!$OMP PARALLEL DEFAULT(SHARED) PRIVATE(I,J,K,FXH,FYH,FXE,FYE)
!$OMP DO
    Do I = 1, IJM
       If(CCM(I) .EQ. 1.0) Then
          FXH = 0.0
          FYH = 0.0
          FXE = 0.0
          FYE = 0.0
            Do J = 1, CELL_POLYGEN(I)
               FXH = FXH +
     &               HS(CELL_SIDE(I,J,1)) *
     &               CELL_CUV(I,J,7) * CELL_CUV(I,J,6)
           FYH = FYH +
     &               HS(CELL_SIDE(I,J,1)) *
     &               CELL_CUV(I,J,8) * CELL_CUV(I,J,6)
             If(CFM(CELL_SIDE(I,J,1)) .EQ. 1.0) Then
                FXE = FXE +
     &              WIX(I,J) * (ELF(CELL_SIDE(I,J,2)) - ELF(I))
            FYE = FYE +
     &              WIY(I,J) * (ELF(CELL_SIDE(I,J,2)) - ELF(I))
           Endif
          Enddo
        Do K = 1, KBM
          WR(I,K) = (W(I,K) + W(I,K+1)) / 2. +
     &        ZZ(K) * (U(I,K) / (HC(I) + ELF(I)) *
     &                 FXH / AREA(I) +
     &                 V(I,K) / (HC(I) + ELF(I)) *
     &                 FYH / AREA(I)) +
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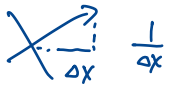
$\int_{cv} \nabla\cdot h\, dv = \int_{cs} h\vec{n}\, ds$

$= h_f \Delta l \cos\delta \Delta\sigma$

$h\Delta l\sin\delta$



$\int_{cv} \nabla\cdot \eta\, dv = \int_{cs} \eta\vec{n}\, ds$

$= \eta_f n_x \Delta\sigma$

q_σ

$q_z(w)$

$\frac{u}{D}\frac{\partial h}{\partial x}$

$\frac{v}{D}\frac{\partial h}{\partial y}$

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     &                    (1. + ZZ(K)) * (U(I,K) / (HC(I)+ELF(I)) * FXE +
     &                                    V(I,K) / (HC(I)+ELF(I)) * FYE +
     &                    (ELF(I) - EL(I)) / DTI)
C    &                   + DHT / DTI
c                QZ(I,K) = WR(I,K) * (HC(I) + ELF(I))

          Enddo
        Endif
      Enddo
!$OMP END DO
!$OMP END PARALLEL
C-------------------------------------------------------------------------------c
        Return
        End
```

$\frac{u}{D}\frac{\partial \eta}{\partial x}$, $\frac{v}{D}\frac{\partial \eta}{\partial y}$; $\frac{\partial \eta}{\partial t}$

$h(x,y)$ $\eta(x,y,t)$

$\sigma = \frac{z-\eta}{D}$, $D = -h-\eta$

$$q_\sigma = \frac{1}{D} q_z - u\left[\frac{\sigma}{D}\frac{\partial h}{\partial x} + \frac{(H\sigma)}{D}\frac{\partial \eta}{\partial x}\right] - v\left[\frac{\sigma}{D}\frac{\partial h}{\partial y} + \frac{(H\sigma)}{D}\frac{\partial \eta}{\partial y}\right] - \frac{\sigma}{D}\frac{\partial \eta}{\partial t}$$

$$\int_{cv} q_z \, dv = q_z A \Delta\sigma$$

$$\int_{cv} \frac{\partial \eta}{\partial t} dv = \frac{\Delta \eta}{\Delta t} A \Delta\sigma$$