2.4. Vjetrovno strujanje u okrajnjim morima: Ekmanov model

Stacionarno strujanje u okrajnjim morima (h $\approx$ $\mathcal{D}$)

prethodno:
- f = const; *U*, *V* (nizozemska škola)
- f = 0; *u*, *v* (ruska škola)

Ekman:
- f = const (≠ 0); *u, v;*

podsjetnik na Ekmanov model struja potiska (FO2):
- neomeđeni ocean u (*x, y, z*), horizontalna razina mora ($\vec{\nabla}_H p = 0$)
- vjetar konstantan i homogen u prostoru

- dinamika: $\vec{\nabla}_H p$, Coriolisova sila, trenje
- na površini vjetar; na dnu pridneno trenje; vjetar i dno prostorno varijabilni

$$w = \underbrace{\frac{\tau}{A\sqrt{\frac{if\rho}{A}}}\frac{\sinh\sqrt{\frac{if\rho}{A}}(D+z)}{\cosh\sqrt{\frac{if\rho}{A}}D}}_{\text{struje potiska}} \underbrace{- \frac{ig}{f}G\left(\frac{\cosh\sqrt{\frac{if\rho}{A}}z}{\cosh\sqrt{\frac{if\rho}{A}}D}-1\right)}_{\text{struje nagiba}}$$

$$w = u + iv$$

$$G = \frac{\partial\zeta}{\partial x} + i\frac{\partial\zeta}{\partial y}$$

2.4. Ekmanov model

(1)

$$u = \frac{1}{A/\Delta}\left(\alpha\tau_x - \beta\tau_y\right) - \frac{g}{f}\left(\gamma\frac{\partial\zeta}{\partial x} - \varepsilon\frac{\partial\zeta}{\partial y}\right)$$

$$v = \frac{1}{A/\Delta}\left(\beta\tau_x + \alpha\tau_y\right) - \frac{g}{f}\left(\gamma\frac{\partial\zeta}{\partial y} + \varepsilon\frac{\partial\zeta}{\partial x}\right)$$

$\Delta = \mathcal{D}/\pi$ (Ekmanova dubina, ~ 14 m)

$\alpha, \beta, \gamma, \varepsilon = \mathrm{f}(z, D)$

u, *v* su funkcije vjetra, nagiba razine mora i batimetrije

- Potrebno je odrediti nagib razine mora: iz vert. integriranih brzina (*U, V*)

(2)

$$U = c_1\tau_x - c_2\tau_y + c_3\frac{\partial\zeta}{\partial x} - c_4\frac{\partial\zeta}{\partial y}\ ,$$

$$V = c_1\tau_y + c_2\tau_x + c_3\frac{\partial\zeta}{\partial y} + c_4\frac{\partial\zeta}{\partial x}$$

c1, c2, c3, c4 = f(δ), δ = D/Δ

(δ: efekt rotacije, trenja i konačne dubine)

- Uvodi se strujna funkcija (Ψ) za *U* i *V*

2.4. Ekmanov model

- Nagib razine mora:

(3)
$$\frac{\partial \zeta}{\partial x} = c_1' \frac{\partial \Psi}{\partial x} + c_2' \frac{\partial \Psi}{\partial y} + c_3' \tau_x + c_4' \tau_y$$

$$\frac{\partial \zeta}{\partial y} = -c_2' \frac{\partial \Psi}{\partial x} + c_1' \frac{\partial \Psi}{\partial y} - c_4' \tau_x + c_3' \tau_y$$

$c'_1, c'_2, c'_3, c'_4 = f(c_1, c_2, c_3, c_4)$

- Potrebno je odrediti strujnu funkciju (Ψ):

(4)
$$c_2'\left(\frac{\partial^2 \Psi}{\partial x^2} + \frac{\partial^2 \Psi}{\partial y^2}\right) + \left(\frac{\partial c_2'}{\partial x} + \frac{\partial c_1'}{\partial y}\right)\frac{\partial \Psi}{\partial x} + \left(\frac{\partial c_2'}{\partial y} - \frac{\partial c_1'}{\partial x}\right)\frac{\partial \Psi}{\partial y} = \underbrace{\left[\frac{\partial}{\partial x}\left(c_3' \tau_y\right) - \frac{\partial}{\partial y}\left(c_3' \tau_x\right)\right]}_{\text{rotor vjetra}} - \underbrace{\left[\frac{\partial}{\partial x}\left(c_4' \tau_x\right) + \frac{\partial}{\partial y}\left(c_4' \tau_y\right)\right]}_{\text{divergencija vjetra}}$$

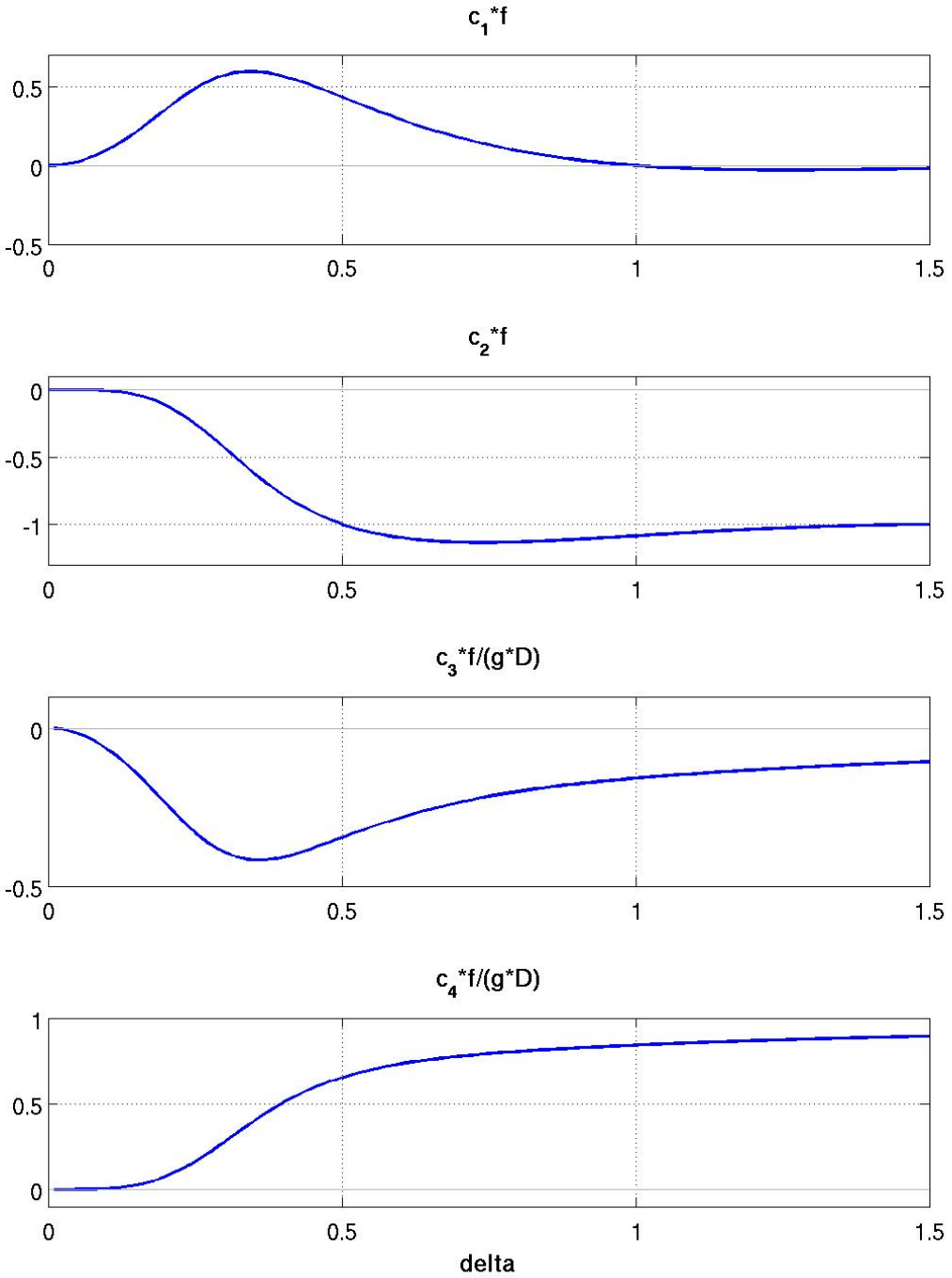
Rješavanje:

- moramo znati razdiobu vjetra nad bazenom
- " (varijabilnu) batimetriju (c'_1, c'_2, c'_3, c'_4)
- moramo zadovoljiti rubne uvjete: i. čvrsta granica: $\vec{v} \cdot \vec{n} = 0$,
  ii. otvorena granica: (npr. rješenje na većoj domeni)

Postupak:

iz (4) → Ψ → (3) → ∂ζ/∂x, ∂ζ/∂y → (2) → U, V
→ (1) → u, v

2.4. Ekmanov model



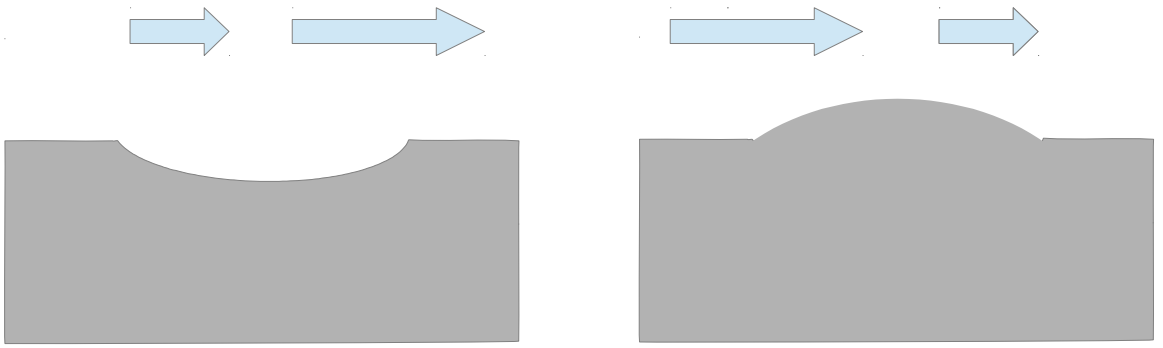
2.4. Ekmanov model: Utjecaj nehomogenog vjetra na razinu mora

Slučaj ravnog dna, za 0 < D < Δ:

$$c_3 \nabla^2 \zeta = -c_1 \left(\vec{\nabla} \cdot \vec{\tau} \right) + c_2 \left(\vec{\nabla} \times \vec{\tau} \right)_z$$

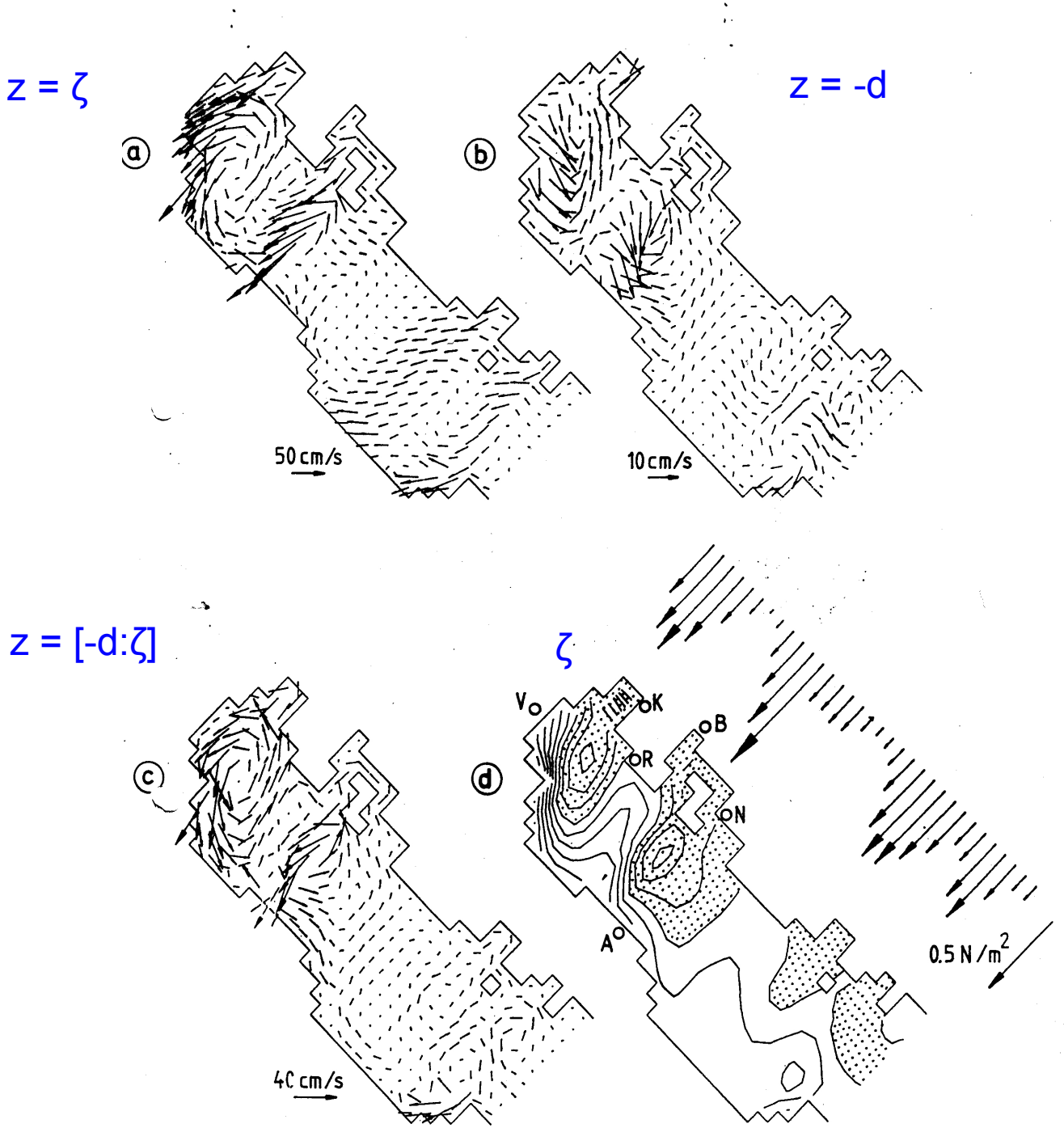
i) djelovanje rotora vjetra

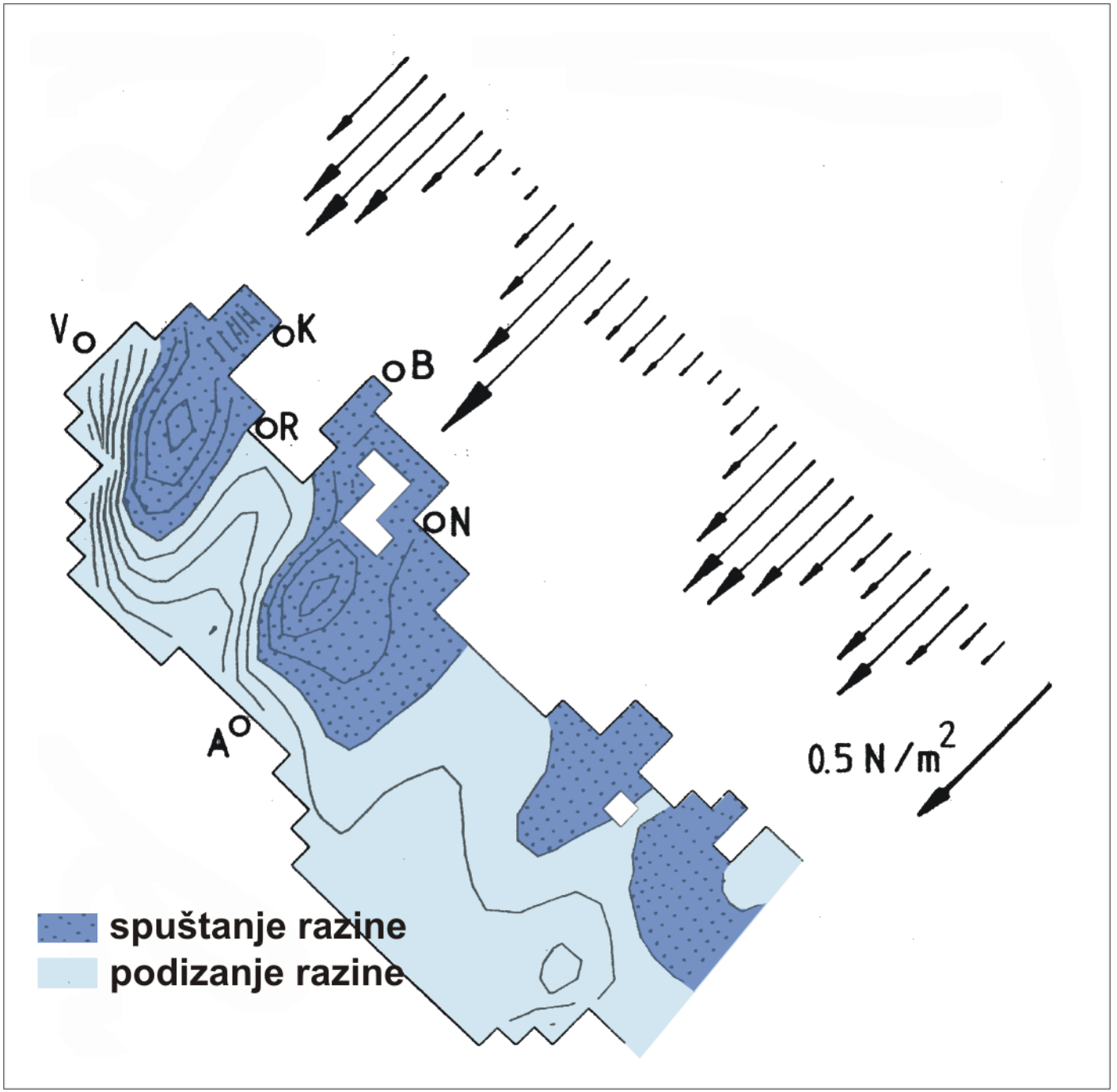
ii) djelovanje divergencije/ konvergencije vjetra



spuštanje razine mora

podizanje razine mora


z = ζ
a
50 cm/s
z = -d
b
10 cm/s
z = [-d:ζ]
c
40 cm/s
ζ
d
V
K
B
R
N
A
0.5 N/m²


Vo
oK
oB
oR
oN
Ao
0.5 N/m2
spuštanje razine
podizanje razine

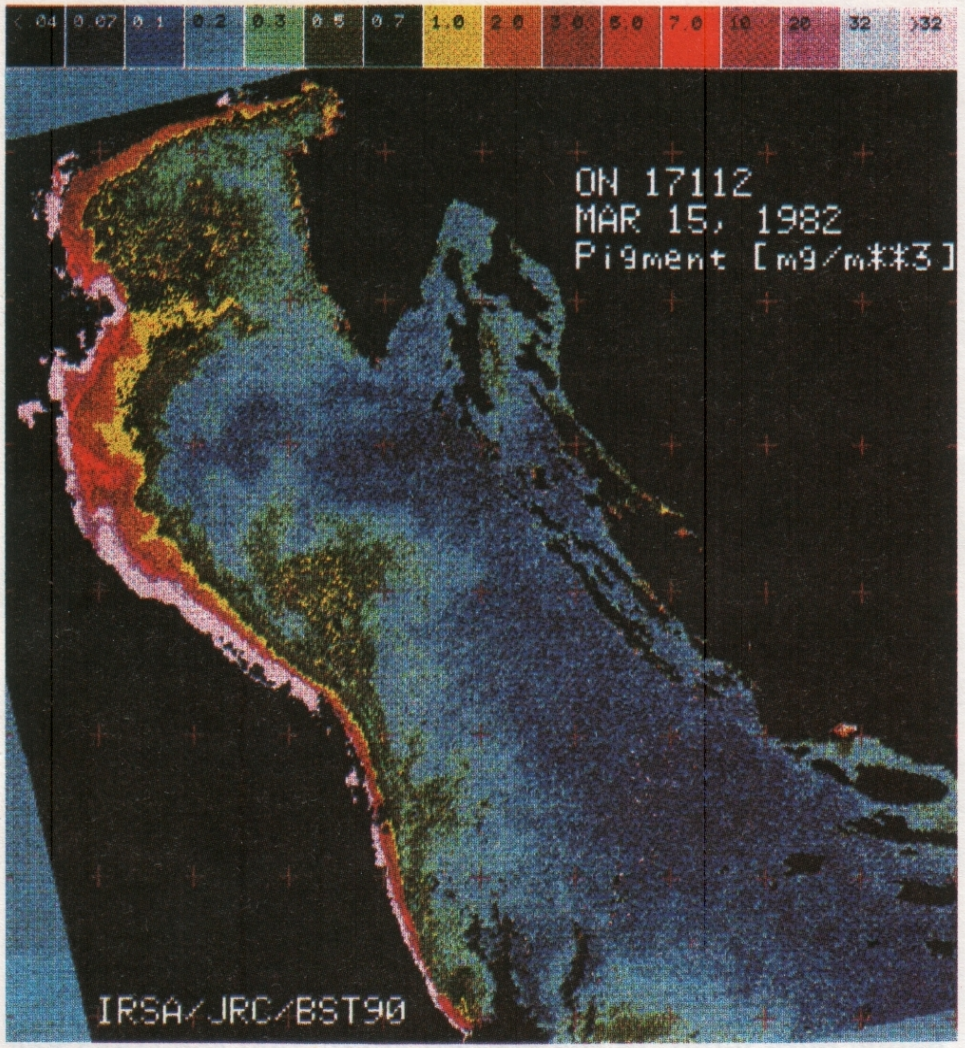


Figure 9

Derived pigment concentration for 15 March 1982 (Orbit No. 17112).

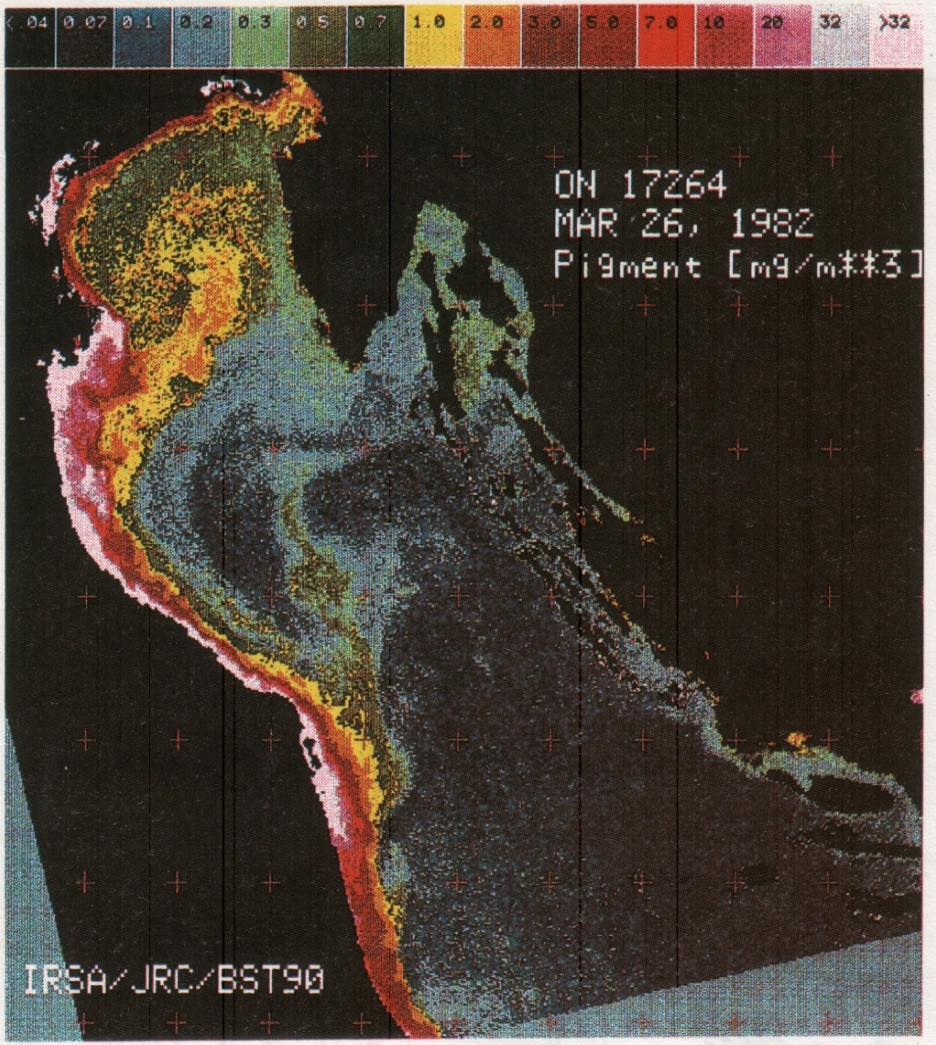
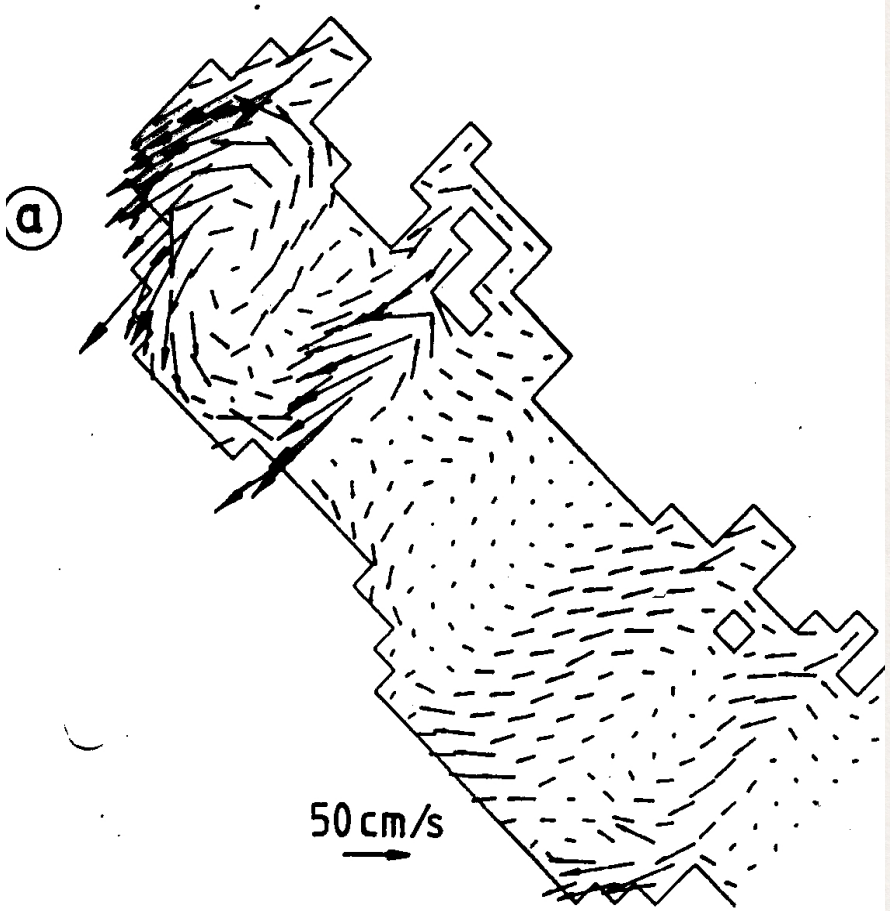


Figure 10

Derived pigment concentration for 26 March 1982 (Orbit No. 17264).



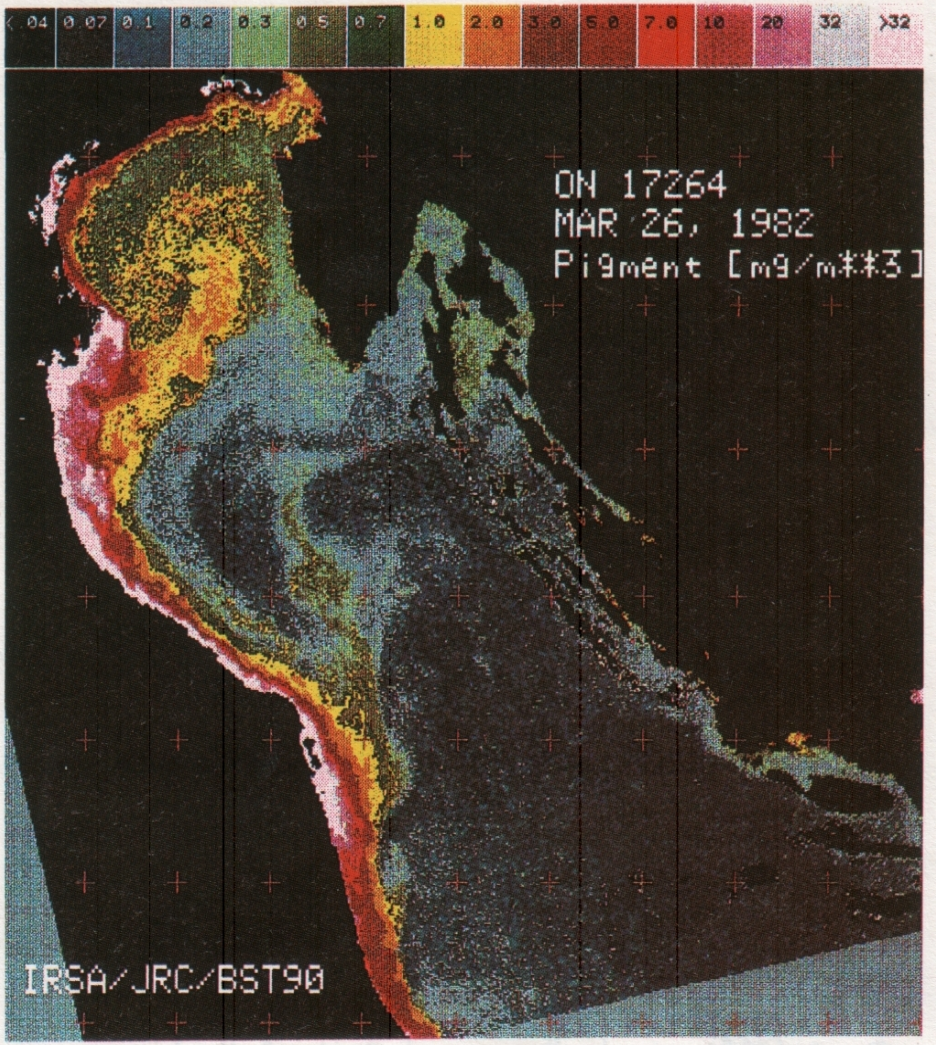


Figure 10

Derived pigment concentration for 26 March 1982 (Orbit No. 17264).